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**(54) Title:** TROPOELASTIN DERIVATIVES

**(57) Abstract**

The invention relates to derivatives of tropoelastin and variants of those derivatives. The invention further provides expression products and hybrid molecules of the derivatives and variants of the invention. The invention further provides methods for the production of the derivatives, variants, expression products and hybrid molecules. Further provided are formulations, cross-linked structures and implants comprising the derivatives, variants, expression products and hybrid molecules of the invention. Further provided are uses of the derivatives, variants, expression products and hybrid molecules of the invention.

# TROPOELASTIN DERIVATIVES

## TECHNICAL FIELD

The present invention relates to derivatives of human tropoelastin and variants thereof, to genetic constructs encoding the amino acid sequences of the derivatives and variants and to uses of the derivatives and variants. In particular, the derivatives of the present invention have elastin-like properties or macro-molecular binding properties.

## BACKGROUND ART

There are various forms of tropoelastin that typically appear to consist of two types of alternating domains: those rich in hydrophobic amino acids (responsible for the elastic properties) and those rich in lysine residues (responsible for cross-link formation). Hydrophobic and cross-linking domains are encoded in separate exons (Indik *et al* 1987).

The 26 A region of human tropoelastin is unique amongst tropoelastin domains in that, due to the absence of lysine, this region does not participate in elastin cross-link formation. Furthermore, this region is a serine-rich domain and lacks hydrophobic stretches, indicating that it is unlikely to contribute to the elasticity of tropoelastin. There is otherwise limited information on the structure and functional relationships of the 26 A region (Bedell-Hogan *et al.*, 1993).

The gene for tropoelastin is believed to be present as a single copy in the mammalian genome, and is expressed in the form of multiple transcripts, distinguished by alternative splicing of the pre-mRNA (Indik *et al*, 1990; Oliver *et al*, 1987). Modest expression of a natural human tropoelastin sequence has been achieved by Indik *et al* (1990) using cDNA, providing free polypeptide which unfortunately was unstable.

Expression of substantial amounts of human tropoelastin using synthetic polynucleotides is reported

in WO94/14958. In particular, a construct, SHEL, providing substantial amounts of full length human tropoelastin is described.

## DESCRIPTION OF THE INVENTION

In the specification and claims, "derivatives of human tropoelastin" or "tropoelastin derivatives" means novel peptides, polypeptides or proteins which contain amino acid sequences derived from the native amino acid sequences of human tropoelastin molecules. The amino acid sequences of the derivatives of human tropoelastin may be derived from any of the amino acid sequences of the isoforms of human tropoelastin. Derivatives of human tropoelastin are distinguished from human tropoelastin molecules in that the amino acid sequences of derivatives are altered with respect to native tropoelastin sequences by substitution, addition or deletion of residues, or a combination of these alterations, in derivative amino acid sequences.

In a first aspect, the present invention provides derivatives of human tropoelastin which have elastin-like properties. Elastin-like properties are a combination of elastic properties, including the phenomenon of recoil following molecular distention under appropriate conditions, and the ability to be cross-linked to other elastin molecules and/or other elastin-like molecules.

In a second aspect, the present invention provides derivatives of human tropoelastin which have macro-molecular binding properties including the ability to bind glycosaminoglycans.

In a third aspect, the present invention provides derivatives of human tropoelastin which have elastin-like properties and macro-molecular binding properties.

The present invention further provides amino acid sequence variants of the derivatives of the invention. In the specification and claims "variants" means amino acid sequences which retain the properties of the corresponding derivative of human tropoelastin, for example, elastin-

like properties or macro-molecular binding properties, or a combination of elastin-like properties and macro-molecular binding properties, and have an amino acid sequence which is homologous with the amino acid sequence of the corresponding derivative. For the purposes of this description, "homology" between the amino acid sequence of a particular derivative of human tropoelastin and another amino acid sequence connotes a likeness short of identity, indicative of a derivation of one sequence from the other. In particular, an amino acid sequence is homologous to a derivative of human tropoelastin if the alignment of that amino acid sequence with the sequence of the derivative of human tropoelastin reveals a similarity of about 65% over any 20 amino acid stretch or over any repetitive element of the molecules shorter than 20 amino acids in length. Such a sequence comparison can be performed via known algorithims, such as that of Lipman and Pearson (1985). Similarity is observed between amino acids where those amino acids have a side chain which confers a similar chemical property in the same chemical environment. For example, threonine and serine are similar amino acids; aspartic acid and glutamic acid are similar amino acids; valine, leucine and isoleucine are similar amino acids etc. Thus, an amino acid sequence may be considered homologous with the amino acid sequence of a human tropoelastin derivative because the alignment of those sequences reveals a similarity of 65%, although at each amino acid position in the aligned sequences, none of the residues are identical.

Inasmuch as the present invention provides derivatives of human tropoelastin and amino acid sequence variants of those derivatives, the invention thus extends to amino acid sequence variants incorporating amino acid sequences of non-human tropoelastins. Amino acid sequence variants which are non-human tropoelastin derivatives, or are based all, or in part, on non-human tropoelastin derivatives retain properties of the corresponding derivative of non-human tropoelastin, for example,

elastin-like properties or macro-molecular binding properties, or a combination of elastin-like properties and macro-molecular binding properties, and have an amino acid sequence which is homologous with the amino acid sequence of the corresponding human derivative. The variants of the invention also include variants of the non-human tropoelastin derivatives, or of derivatives based on the non-human tropoelastin derivatives. "Homology" between the amino acid sequence of a particular derivative of non-human tropoelastin and another amino acid sequence connotes a likeness short of identity, indicative of a derivation of one sequence from the other. In particular, an amino acid sequence is homologous to a derivative of non-human tropoelastin if the alignment of that amino acid sequence with the sequence of the derivative of non-human tropoelastin reveals a similarity of about 65% over any 20 amino acid stretch or over any repetitive element of the molecules shorter than 20 amino acids in length. The skilled addressee will understand that species that are substantially phylogenetically related to humans express tropoelastin molecules which consist of amino acid sequences with homology to human tropoelastin amino acid sequences. Indeed, amino acid sequences of non-human tropoelastins have been determined, including the amino acid sequences of chick tropoelastin, bovine tropoelastin and rat tropoelastin (Bressan *et al.* 1987, Raju *et al.* 1987, Pierce *et al.* 1992) and over multiple regions, these are homologous with the human tropoelastin amino acid sequences. The skilled addressee will recognise therefore, that derivatives of human tropoelastin and amino acid sequence variants of those derivatives will necessarily encompass corresponding tropoelastin amino acid sequences from these and other non-human species.

The present invention provides a tropoelastin derivative comprising the amino acid sequence of SHELδmodified (SEQ ID NO:5). The amino acid sequence of

SHELδmodified and the alignment of that amino acid sequence with the human tropoelastin sequence is shown in Figure 5.

The invention also provides an amino acid sequence variant of the derivative comprising the amino acid sequence of SHELδmodified.

The invention also provides a polynucleotide encoding a tropoelastin derivative comprising the amino acid sequence of SHELδmodified. The nucleotide sequence encoding SHELδmodified is shown in Figure 3 (SEQ ID NO: 4). Preferably the polynucleotide comprises the nucleotide sequence which corresponds to SHELδmodified shown in Figure 3.

The invention also provides a polynucleotide encoding an amino acid sequence variant of the derivative SHELδmodified.

The present invention further provides a synthetic polynucleotide encoding a tropoelastin derivative comprising the amino acid sequence of SHELδ26A (SEQ ID NO:3). A synthetic polynucleotide is a molecule which comprises a nucleotide sequence that contains silent mutations with respect to the corresponding native polynucleotide molecule. The silent mutations enhance the expression of the synthetic polynucleotide. The amino acid sequence of SHELδ26A and the alignment of that amino acid sequence with the human tropoelastin sequence is shown in Figure 2. The SHELδ26A derivative excludes the SHEL coding sequence corresponding to exon 26A. Preferably the synthetic polynucleotide comprises the sequence shown in Figure 1 (SEQ ID NO:1) from nucleotide position 1 to 1676 contiguous with nucleotide position 1775 to 2210.

The invention also provides a polynucleotide encoding an amino acid sequence variant of the derivative SHELδ26A.

The invention also provides an amino acid sequence

variant of the derivative comprising the amino acid sequence of SHELδ26A.

The present inventor has, for the first time, shown that the region encoded by exon 26A (peptide 26A) of the tropoelastin gene binds glycosaminoglycans (GAGs) (Figure 6A and B). GAGs are macro-molecules particularly associated with the extracellular environment. These molecules play an important role in the architecture and mechanical properties of connective tissues and mediate interactions with and availability of other molecules.

Thus, the present invention provides a tropoelastin derivative comprising the amino acid sequence of peptide 26A. Peptide 26A has the amino acid sequence: GADEGVRRSLSPELREGDPSSSQHLPSTPSSPRV (SEQ ID NO: 12) or GADEGVRRSLSPELREGDPSSSQHLPSTPSSPRF (SEQ ID NO: 13).

The present invention also provides an amino acid sequence variant of the derivative comprising the amino acid sequence of peptide 26A.

The invention also provides a polynucleotide encoding a tropoelastin derivative comprising the amino acid sequence of peptide 26A. Preferably the polynucleotide comprises the nucleotide sequence shown in Figure 1 (SEQ ID NO: 1) from nucleotide position 1687 to 1778. Preferably the 3′ terminal codon is GTT (which encodes V) or TTT (which encodes F).

The invention also provides a polynucleotide encoding an amino acid sequence variant of the derivative comprising the amino acid sequence of peptide 26A.

In appreciating the GAG binding property of peptide 26A, the present inventor envisages the generation of novel subsets of hybrid molecules, comprising biological polymers which are linked to peptide 26A, wherein the peptide 26A imparts GAG binding activity to the polymer. In particular, the present inventor has recognised that the deletion or insertion of the peptide 26A amino acid sequence, or a variant of that amino acid sequence will alter GAG binding activity. Thus, the present invention relates to tropoelastin derivatives in which full length

or partial length tropoelastin molecules have been modified by the addition of one or more exon 26A regions to enhance interactions with GAGs. Moreover, the invention relates to site directed modification of the amino acid sequence of peptide 26A so as to generate variants of the peptide 26A amino acid sequence which have altered affinity or altered specificity for GAGs. Tropoelastin derivatives or variants of the derivatives which contain altered GAG binding activity may be uncross-linked or cross-linked.

In another aspect, the invention provides a hybrid molecule. In the specification and claims, "hybrid molecule" means a molecule comprising a biological polymer which is linked to a tropoelastin derivative comprising the amino acid sequence of peptide 26A or an amino acid sequence variant of a derivative comprising the amino acid sequence of peptide 26A. Preferably the biological polymer is a protein. More preferably the protein is selected from the group consisting of growth factors, cytokines and antibodies. Alternatively the biological polymer is selected from the group consisting of lipids, sugars or nucleic acids.

In one embodiment, and where the biological polymer is a protein, the hybrid molecule is produced by recombinant DNA techniques, including for example the construction of a nucleotide sequence which encodes the biological polymer and the tropoelastin derivative comprising the amino acid sequence of peptide 26A, or the amino acid sequence variant of a derivative comprising the amino acid sequence of peptide 26 A, in a single open reading frame. Alternatively, the hybrid molecule may be produced synthetically by solid phase peptide synthesis, including, for example the methods of synthesis disclosed in Merrifield (1963) or Knorr *et al.* (1989). Examples of peptide synthesis also include the synthesis methods used by peptide synthesisers of Perkin Elmer/Applied Biosystems, CA, US.

In another aspect, the invention provides a

polynucleotide sequence encoding a hybrid molecule of the invention.

In another aspect, the invention provides a hybrid molecule which comprises a synthetic polymer which is linked in a tropoelastin derivative comprising the amino acid sequence of peptide 26A, or an amino acid sequence variant of the derivative comprising the amino acid sequence of peptide 26A.

The invention further provides a method of imparting or enhancing GAG binding activity to a biological polymer comprising the step of linking a tropoelastin derivative comprising the amino acid sequence of peptide 26A, or an amino acid sequence variant of peptide 26A with the biological polymer. Preferably the biological polymer is a protein.

The invention further provides a method of deleting or reducing GAG binding activity from a biological polymer comprising the step of deleting a tropoelastin derivative comprising the amino acid sequence of peptide 26A, or an amino acid sequence variant of peptide 26A from the biological polymer. Preferably the biological polymer is a protein.

The present invention also provides a tropoelastin derivative comprising the amino acid sequence of SHELgamma. SHELgamma has the amino acid sequence:
SAMGALVGLGVPGLGVGAGVPGFGAGADEGVRRSLSPELREGDPSSSQHLPSTPSSPR
VPGALAAAKAAKYGAAVPGVLGGLGALGGVGIPGGVVGAGPAAAAAAAKAAAKAAQFG
LVGAAGLGGLGVGGLGVPGVGGLGGIPPAAAAKAAKYGAAGLGGVLGGAGQFPLGGVA
ARPGFGLSPIFPGGACLGKACGRKRK (SEQ ID NO: 9).

The invention also provides an amino acid sequence variant of the derivative comprising the amino acid sequence of SHELgamma.

The invention also provides a polynucleotide encoding a tropoelastin derivative, the derivative comprising the amino acid sequence of SHELgamma. The nucleotide sequence of the polynucleotide SHELgamma (SEQ ID NO: 8) is shown in Figure 8. In this nucleotide sequence, the first 9 codons from nucleotide position 948 to 974 are derived

from the glutathione *S*-transferase (GST) fusion nucleotide sequence. Preferably the polynucleotide comprises the nucleotide sequence shown in Figure 8. More preferably the polynucleotide comprises the nucleotide sequence shown in Figure 8 from nucleotide sequence position 975 to 1547.

The invention also provides a polynucleotide encoding an amino acid sequence variant of the derivative comprising the amino acid sequence of SHELgamma.

The present invention also provides a polynucleotide encoding a tropoelastin derivative, the derivative comprising the amino acid sequence of SHELgamma excluding exon 26A. The nucleotide sequence of the polynucleotide SHELgamma excluding exon 26A (SEQ ID NO: 6) is shown in Figure 7. In this nucleotide sequence, the first 5 codons from nucleotide position 948 to 962 are derived from the GST nucleotide sequence. SHELgamma excluding exon 26A has the following amino acid sequence:
VPGALAAAKAAKYGAAVPGVLGGLGALGGVGIPGGVVGAGPAAAAAAAKAAAKAAQFG
LVGAAGLGGLGVGGLGVPGVGGLGGIPPAAAAKAAKYGAAGLGGVLGGAGQFPLGGVA
ARPGFGLSPIFPGGACLGKACGRKRK (SEQ ID NO: 7).
Preferably the polynucleotide comprises the nucleotide sequence shown in SEQ ID NO:6. More preferably the polynucleotide comprises the nucleotide sequence shown in SEQ ID NO: 6 from nucleotide sequence position 15 to 441.

The invention also provides a polynucleotide encoding an amino acid sequence variant of the derivative comprising the amino acid sequence of SHELgamma excluding exon 26A.

The invention also provides a tropoelastin derivative comprising the amino acid sequence of SHELgamma excluding exon 26A.

The invention also provides an amino acid sequence variant of the derivative comprising SHELgamma excluding exon 26A.

The derivatives of the invention based on SHELgamma can also be produced by *in vitro* biochemical cleavage of tropoelastin products such as SHEL, so as to release a carboxy- terminal fragment. The carboxy-terminal fragment

may be purified by reverse phase HPLC.

The present invention also provides a tropoelastin derivative comprising the amino acid sequence of SHEL31-36. SHEL31-36 has the following amino acid sequence: GIPPAAAAKAAKYGAAGLGGVLGGAGQFPLGGVAARPGFGLSPIFPGGACLGKACG-RKRK (SEQ ID NO: 10).

SHEL31-36 retains a crosslinking domain. As a consequence of its elastin-like properties, it is envisaged that this and related tropoelastin derivatives can be used to interfere with tropoelastin deposition and formation of unaltered elastic fibre.

The invention also provides an amino acid sequence variant of the derivative comprising the amino acid sequence of SHEL31-36.

The invention also provides a polynucleotide encoding a tropoelastin derivative, the derivative comprising the amino acid sequence of SHEL31-36. Preferably the polynucleotide comprises the nucleotide sequence shown in Figure 1 (SEQ ID NO:1) from nucleotide position 2022 to 2210.

The invention also provides a polynucleotide encoding an amino acid variant of the derivative comprising the amino acid sequence of SHEL31-36.

The present invention also provides a tropoelastin derivative, comprising the amino acid sequence of SHEL32-36. SHEL32-36 has the following amino acid sequence: GAAGLGGVLGGAGQFPLGGVAARPGFGLSPIFPGGACLGKACGRKRK (SEQ ID NO: 11).

The invention also provides an amino acid sequence variant of the derivative comprising the amino acid sequence of SHEL32-36.

The invention also provides a polynucleotide encoding a tropoelastin derivative, the derivative comprising the amino acid sequence of SHEL32-36. Preferably the polynucleotide comprises the nucleotide sequence shown in Figure 1 (SEQ ID NO: 1) from nucleotide position 2061 to 2210.

The present invention also provides a polynucleotide

encoding an amino acid sequence variant of the derivative comprising the amino acid sequence of SHEL32-36.

As a consequence of its elastin-like properties, it is envisaged that SHEL32-36 and related tropoelastin derivatives can be used to interfere with tropoelastin deposition and formation of an unaltered elastic fibre.

The present invention also provides a tropoelastin derivative, comprising the amino acid sequence of SHEL26-36. SHEL26-36 has the following amino acid sequence:
AAAGLGAGIPGLGVGVGVPGLGVGAGVPGLGVGAGVPGFGAGADEGVRRSLSPELREGD
PSSSQHLPSTPSSPRVPGALAAAKAAKYGAAVPGVLGGLGALGGVGIPGGVVGAGPAAA
AAAAKAAAKAAQFGLVGAAGLGGLGVGGLGVPGVGGLGGIPPAAAAKAAKYGAAGLGGV
LGGAGQFPLGGVAARPGFGLSPIFPGGACLGKACGRKRK (SEQ ID NO: 14)

The invention also provides an amino acid sequence variant of the derivative comprising the amino acid sequence of SHEL26-36.

The invention also provides a polynucleotide encoding a tropoelastin derivative, the derivative comprising the amino acid sequence of SHEL26-36. Preferably the polynucleotide comprises the nucleotide sequence shown in Figure 1 from nucleotide position 1554-2210.

The present invention also provides a tropoelastin derivative, comprising the amino acid sequence of SHEL26-36 excluding exon 26A. SHEL26-36 excluding exon 26A has the following amino acid sequence:
AAAGLGAGIPGLGVGVGVPGLGVGAGVPGLGVGAGVPGFGAVPGALAAAKAAKYGAAVP
GVLGGLGALGGVGIPGGVVGAGPAAAAAAKAAAKAAQFGLVGAAGLGGLGVGGLGVPG
VGGLGGIPPAAAAKAAKYGAAGLGGVLGGAGQFPLGGVAARPGFGLSPIFPGGACLGKA
CGRKRK (SEQ ID NO: 15)

The invention also provides an amino acid sequence variant of the derivative comprising the amino acid sequence of SHEL26-36 excluding exon 26A.

The invention also provides a polynucleotide encoding a tropoelastin derivative, the derivative comprising the amino acid sequence of SHEL26-36 excluding exon 26A. Preferably the polynucleotide comprises the nucleotide sequence shown in Figure 1 from nucleotide position 1554

to 1676 contiguous with 1776 to 2210.

The present invention also provides a polynucleotide encoding an amino acid sequence variant of the derivative comprising the amino acid sequence of SHEL26-36.

In another aspect the present invention provides a formulation comprising a tropoelastin derivative, a variant of the derivative or a hybrid molecule of the invention, together with a carrier or diluent.

Formulations of the derivatives, variants or hybrid molecules of the invention can be prepared in accordance with standard techniques appropriate to the field in which they are to be used.

The polynucleotides and synthetic polynucleotides of the invention can be provided in association with other polynucleotide sequences including 5′ and 3′ untranslated sequences, and 5′ upstream and 3′ downstream transcriptional regulatory sequences. The polynucleotides and synthetic polynucleotides may be provided as a recombinant DNA molecule including plasmid DNA.

The polynucleotides and synthetic polynucleotides of the invention can be prepared using the techniques of chemical synthesis or recombinant DNA technology, or by a combination of both techniques.

In a further aspect the invention provides a vector comprising a polynucleotide or synthetic polynucleotide encoding a tropoelastin derivative, a variant of the derivative or a hybrid molecule of the invention.

Vectors useful in this invention include plasmids, phages and phagemids. The polynucleotides and synthetic polynucleotides of the present invention can also be used in integrative expression systems or lytic or comparable expression systems.

Suitable vectors will generally contain origins of replication and control sequences which are derived from species compatible with the intended expression host. Typically these vectors include a promoter located upstream from the polynucleotide, together with a ribosome binding site if intended for prokaryotic expression, and a

phenotypic selection gene such as one conferring antibiotic resistance or supplying an auxotrophic requirement. For production vectors, vectors which provide for enhanced stability through partitioning may be chosen. Where integrative vectors are used it is not necessary for the vector to have an origin of replication. Lytic and other comparable expression systems do not need to have those functions required for maintenance of vectors in hosts.

For *E. coli* typical vectors include pBR322, pBluescript II SK$^{+}$, pGEX-2T, pTrc99A, pET series vectors, particularly pET3d, (Studier *et al.*, 1990) and derivatives of these vectors. Derivatives include those plasmids with a modified protease recognition sequence to facilitate purification of a protein domain.

In another aspect the invention provides a cell capable of expressing a polynucleotide or a synthetic polynucleotide which encodes a derivative or variant of the invention, or a polynucleotide which encodes a hybrid molecule of the invention.

A preferred expression system is an *E. coli* expression system. However, the invention includes within its scope the use of other hosts capable of expressing protein from the polynucleotides designed for use in *E. coli*. The invention also includes the use of polynucleotides and synthetic polynucleotides suitable for use in other expression systems such as other microbial expression systems. These other expression systems include yeast, and bacterial expression systems, insect cell expression systems, and expression systems involving other eukaryotic cell lines or whole organisms.

Examples of *E. coli* hosts include *E. coli* B strain derivatives (Studier *et al*, 1990), and K-strain derivatives such as NM522 (Gough and Murray, 1983) and XL1-Blue (Bullock *et al*, 1987).

In a further aspect the present invention provides an expression product. In the specification and claims, "expression product" means a derivative or variant of the

invention expressed by a cell containing a polynucleotide or a synthetic polynucleotide encoding a derivative or variant of the invention.

The expression products of the invention may be fused expression products which include all or part of a protein encoded by the vector in peptide linkage with the derivative or variant. They may also include, for example, an N-terminal methionine or other additional residues which do not permanently impair the elastin-like, or macro-molecular binding properties of the product.

Typically the fusion is to the N-terminus of the expression product. An example of a suitable protein is to the C-terminus of glutathione *S*-transferase. The fused protein sequence may be chosen in order to cause the expression product to be secreted or expressed as a cell surface protein to simplify purification or expressed as a cytoplasmic protein.

The expressed fusion products may subsequently be treated to remove the fused protein sequences to provide free tropoelastin derivative or variant. Treatment is typically through protease treatment or, in the case of secretion, removal is effected by endogenous host secretion machinery. An example of this is secretion by yeasts.

Non-fused systems include the introduction of or use of a pre-existing methionine codon. An example of this is the use of pET3a or pET3d in *E. coli*.

In another aspect the invention provides a polynucleotide encoding an expression product of the invention.

In another aspect the present invention provides a formulation comprising an expression product of the invention together with a carrier or diluent. The formulation of the expression product can be prepared in accordance with standard techniques appropriate to the field in which they are used.

According to a further aspect of the present invention there is provided a method for producing a

tropoelastin derivative or a variant of the derivative comprising providing a vector containing a polynucleotide or a synthetic polynucleotide encoding the derivative or variant; introducing the vector into a suitable host cell; maintaining the cell in conditions suitable for expression of the polynucleotide or synthetic polynucleotide and isolating the derivative or variant of the invention. The method can be applied to the production of the expression products and hybrid molecules (in which the hybrid molecules comprise the peptide 26A or a variant thereof and a further amino acid sequence) of the invention, by providing a vector containing a polynucleotide encoding an expression product or a hybrid molecule; introducing the vector into a suitable host cell; maintaining the cell in conditions suitable for expression of the polynucleotide and isolating the expression product or hybrid molecule.

In one embodiment, the polynucleotide or synthetic polynucleotide encoding the derivative, variant, expression product or hybrid molecule of the invention is expressed in a host cell which is maintained in culture *in vitro*.

Alternatively, the polynucleotide or synthetic polynucleotide encoding the derivative, variant, expression product or hybrid molecule of the invention is expressed in a host cell which is maintained *in vivo*. Thus, in another embodiment, the polynucleotide or synthetic polynucleotide encoding the derivative, variant, expression product or hybrid molecule of the invention is expressed in a transgenic animal. Methods for the generation of transgenic animals are known in the art. Exemplary methods are described in Slack et al. 1991 and Janne et al. 1992.

The tropoelastin derivatives, variants of the derivatives, and hybrid molecules (in which the hybrid molecules comprise the peptide 26A or a variant thereof and a further amino acid sequence) of the invention may be produced by solid phase peptide synthesis, including, for example, the methods of synthesis disclosed in Merrifield

(1963) or Knorr *et al (1989)*. Examples of peptide synthesis also include the synthesis methods used by peptide synthesisers of Perkin Elmer/Applied Biosystems, CA, US. As an alternative to cell synthesis from a polynucleotide or synthetic polynucleotide, the expression products of the invention may be produced by solid phase peptide synthesis.

In a further aspect the present invention provides an implant formed from at least one tropoelastin derivative and/or variant of the derivative of the invention. The implant may alternatively contain at least one expression product and/or at least one hybrid molecule of the invention.

The implants are formed into the required shape by cross-linking the tropoelastin derivative, variant of the derivative, expression product, or hybrid molecule of the invention, in a mould which conforms to the desired shape of the implant. Where the implant is required to be used in sheet form the tropoelastin derivative, variant of the derivative, expression product, or hybrid molecule of the invention can be cross-linked on a flat surface. Relevant methodologies are described in, for example, US Patent No. 4 474 851 and US Patent No. 5 250 516. The elastomeric materials may be exclusively prepared from one or more tropoelastin derivatives, variants of the derivative, expression products, or hybrid molecules of the invention or may be composites prepared from one or more of these constituents together with other materials.

The tropoelastin derivatives or variants of the derivatives can be cross-linked to form elastin or elastin-like material or can be cross-linked in conjunction with other biological or synthetic molecules to form a composite material.

Thus in another aspect the invention provides a cross-linked complex which comprises at least one tropoelastin derivative of the invention and/or at least one variant of a derivative of the invention. The cross-linked complexes may additionally contain at least one

expression product and/or at least one hybrid molecule of the invention, which may be cross-linked to the at least one tropoelastin derivative and/or variant of the derivative of the invention.

The cross-linking of the tropoelastin derivatives, variants of the derivatives, hybrid molecules and expression products of the invention can be achieved by chemical oxidation of lysine side chains using processes such as ruthenium tetroxide mediated oxidation and quinone mediated oxidation, or by using homobifunctional chemical cross-linking agents such as dithiobis (succinimidylpropionate), dimethyl adipimidate or dimethyl pimelimidate. Glutaraldehyde cross-linking is an important addition to this repetoire. Another alternative is the cross-linking of lysine and glutamic side chains.

The tropoelastin derivatives, variants of the derivatives, hybrid molecules and expression products of the invention may also be enzymatically cross-linked by methods including lysyl oxidase mediated oxidation or may be cross-linked using gamma irradiation.

## BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1: Nucleotide (SEQ ID NO: 1) and predicted amino acid (SEQ ID NO:2) sequences of synthetic human tropoelastin SHEL. The upper (numbered) nucleotide sequence represents the coding strand.

Figure 2: Alignment of SHEL (SEQ ID NO:2)(upper line) and SHELδ26A (SEQ ID NO: 3) amino acid sequences.

Figure 3: Nucleotide (SEQ ID NO: 4) and predicted amino acid (SEQ ID NO: 5) sequences of SHELδmodified.

Figure 4: Alignment of SHELδmodified (SEQ ID NO: 4) (upper line) and SHEL (SEQ ID NO:1) nucleotide sequences.

Figure 5: Alignment of SHELδmodified (SEQ ID NO: 5)(lower line) and SHEL (SEQ ID NO: 1) amino acid sequences.

Figure 6A: HPLC elution profile of GST-exon 26A fusion protein tropoelastin derivative loaded in from

heparin sepharose. 6B: Binding of peptide 26A (SEQ ID NO: 12 and SEQ ID NO: 13) to glycosaminoglycans.

Figure 7: Nucleotide (SEQ ID NO: 6) and predicted amino acid (SEQ ID NO: 7) sequences of SHELgamma excluding exon 26A.

Figure 8: Nucleotide (SEQ ID NO: 8) and predicted amino acid (SEQ ID NO: 9) sequences of SHELgamma.

## BEST METHOD OF PERFORMING THE INVENTION

The recombinant and synthetic procedures used for the synthesis of the derivatives, variants, expression products and hybrid molecules of the invention are described in standard texts such as Sambrook *et al* (1989).

Tropoelastin nucleotide sequences may be modified so as to provide derivatives, variants, expression products or hybrid molecules, by conventional site-directed or random mutagenesis. The sequences may also be modified by oligonucleotide-directed mutagenesis, which comprises the following steps:

1. synthesis of an oligonucleotide with a sequence that contains the desired nucleotide substitution (mutation);
2. hybridising the oligonucleotide to a template comprising a structural sequence encoding tropoelastin; and
3. using a DNA polymerase to extend the oligonucleotide as a primer.

Another approach which is particularly suited to situations where a synthetic polynucleotide encoding the tropoelastin derivative is prepared from oligonucleotide blocks bounded by restriction sites, is cassette mutagenesis where entire restriction fragments are replaced.

Purification of the derivatives, variants, expression products or hybrid molecules of the invention is performed using standard techniques including HPLC. The actual sequence of steps in the purification of a particular derivative, variant, expression product or hybrid molecule

is limited by the environment from which the molecule is to be purified. By way of example, reference is made to the purification scheme disclosed in WO94/14958.

Formulations in accordance with the invention are formulated in accordance with standard techniques.

The amount of derivative, variant, expression product or hybrid molecule that may be combined with a carrier or diluent to produce a single dosage will vary depending on the situation in which the formulation is to be used and the particular mode of administration.

It will be understood also that specific doses for any particular host may be influenced by factors such as the age, sex, weight and general health of the host as well as the particular characteristics of the derivative, variant, expression product or hybrid molecule of the invention being used, and how it is administered.

Injectable preparations, for example, sterile injectable aqueous or oleagenous suspensions may be formulated according to the known art using suitable dispersing or wetting agents and suspending agents. The sterile injectable preparation may also be a sterile injectable solution or suspension in a non-toxic parenterally acceptable diluent or solvent. Among the acceptable vehicles or solvents that may be employed are water, Ringer's solution, alcohols and isotonic sodium chloride solution. In addition, sterile, fixed oils are conventionally employed as a solvent or suspending medium. For this purpose any bland fixed oil may be employed including synthetic mono- or diglycerides. In addition, fatty acids such as oleic acid and organic solvents find use in the preparation of injectables.

Routes of administration, dosages to be administered as well as frequency of administration are all factors which can be optimised using ordinary skill in the art.

In addition, the derivatives, variants, expression products and hybrid molecules of the invention may be prepared as topical preparations for instance as anti-wrinkle and hand lotions using standard techniques for the

preparation of such formulations. They may be prepared in aerosol form for, for instance, administration to a patient's lungs, or in the form of surgical implants, foods or industrial products by standard techniques.

SHEL

The preparation of SHEL is described in WO94/14958. It is directly expressed as a full length human protein with a calculated molecular weight of 64kDa. The full nucleotide sequence and corresponding amino acid sequence of SHEL is shown in Figure 1. The preparation of pSHELF is described in WO94/14958.

pSHELF differs from the natural coding sequence(s) in a number of ways. As described in WO94/14958, the untranslated regions present in the tropoelastin cDNA sequence were disregarded in designing the synthetic gene, and the nucleotides encoding the signal peptide were removed. Restriction endonuclease recognition sites were incorporated at regular intervals into the gene by typically altering only the third base of the relevant codons, thereby maintaining the primary sequence of the gene product. The facility for silent alteration of the coding sequence was also exploited to change the codon bias of the tropoelastin gene to that commonly found in highly expressed *E.coli* genes. [Genetics Computer Group (GCG) package version 7-UNIX using Codon Frequency and Gen Run Data: ecohigh-cod]. Two additional stop codons were added to the 3'-end, and an ATG start codon comprising a novel NcoI site was appended to the 5'-end. *Bam* HI cloning sites were engineered at both ends of the synthetic sequence. Since the gene contains no internal methionine residues, treatment of the newly-synthesized gene product (expressed directly or as a fusion with another gene) with cyanogen bromide would liberate a protein with the same or similar sequence as one form of natural tropoelastin comprising 731 amino acids. Other forms of processing are envisaged, which may generate tropoelastin species of the same or different lengths.

Two stop codons were added in order to allow the possible use of the construct in suppressor hosts, and also to avoid any potential depletion of termination (release) factors for translation.

As described in the following examples, the derivatives, pSHELFδ26A, pSHELFδ modified, pSHELgamma, pSHEL31-36, pSHEL32-36 and pSHELgammaδ26A were derived from the pSHELF nucleotide sequence. These particular derivatives, and indeed the derivaties, variants, expression products and hybrid molecules of the invention can equally be derived from a native human or non -human tropoelastin nucleotide sequence.

Example 1: Construction of pSHELFδ26A and pSHELFδ modified

Mutagenesis was used with pSHELF to remove DNA corresponding to exon 26A. The sequence of the mutagenic primer was:

5'CGG GTT TCG GTG CTG TTC CGG GCG CGC TGG 3'

This flanked either side of exon 26A by 15bp resulting in its precise deletion. A second selection primer, which mutates a unique restriction site to another restriction site is normally used in the protocol but was not in this case since deletion of exon 26A also resulted in the deletion of a unique restriction site, *Pml*I. The enzyme *Pml*I was used to treat the mutation reaction to linearise any unmutated parental plasmid and consequently to enrich for mutant plasmid. The reaction mixture was used to transform competent BMH17-18 *mutS E. coli*, defective in mismatch repair, by electroporation and the entire transformed culture was grown overnight in LB+ampicillin. Mixed plasmid DNA, containing both mutated and parental plasmids, was isolated from the culture and the plasmid DNA was digested with *Pml*I to linearise the parental plasmid. The plasmid DNA, now enriched for mutated plasmid, was used to transform *E. coli* HMS174 by electroporation and transformants selected on LB plates

containing 75µgml$^{-1}$ ampicillin.

Colonies were grown overnight and plasmid mini-preparations performed. Constructs were screened using *Pml*I and those which were insensitive to digestion were further screened by *Kpn*I/*Pst*I double digestion. Candidate clones were sequenced to verify the sequence, named pSHELFδmodified.

Sequencing confirmed the region immediately surrounding the deletion was correct. *Pst*I and *Bss*HII restriction sites surrounding the correct region of pSHELFδmodified were used to remove the desired segment and re-insert it into the corresponding site of pSHELF. 6.5µg pSHELF and 7.5µg pSHELFδmodified were digested with *Bss*HII, precipitated and digested with *Pst*I. The appropriate three fragments were gel-purified and ligated. DNA was transformed into *E. coli* XL1-Blue and transformants selected on plates containing 75µgml$^{-1}$ ampicillin.

Plasmids were isolated by mini-preparations and screened using *Bgl*I digestion. A candidate clone was further analysed by restriction enzyme digestion and sequenced, and named pSHELFδ26A.

Example 2: Synthesis of Exon 26A

The region of SHEL corresponding to exon 26A was amplified by PCR, with primers modified to introduce an in-frame BamH1 site upstream and a stop codon downstream at the 3′ end. Two forms were generated: one terminating in valine (26AV) and the other terminating in phenyalanine (26AF). These forms are as follows:
GADEGVRRSLSPELREGDPSSSQHLPSTPSSPRV with properties:

Molecular weight = 3588.80
Residues = 34
Average Residue Weight = 105.553
Charge = -1
Isoelectric point = 5.71

and

GADEGVRRSLSPELREGDPSSSQHLPSTPSSPRF

A 26A coding region was expressed as a glutathione S-transferase (GST) fusion protein.

Example 3: Glycosaminoglycan binding activity of Exon 26A

Ultrafiltration assay methodology was developed to examine and quantify interactions occurring *in vitro* between the 26A region and purified extracellular matrix glcosaminoglycans. GST26A fusion protein and tropoelastin were compared with GST and tropoelastin lacking exon 26A at physiologicaly relevant conditions of pH and ionic strength.

Experimental evidence supports the notion that peptide 26A (26AF and 26AV) binds GAGs. Immobilised heparin column binding shows that GST26A binds more tightly than does GST, and requires a higher sodium chloride concentration for elution (Figure 6B). Furthermore, GST26A fusion protein binds radioactive heparin with greater efficiencies than GST, and these can be compared with GAGs including chondroitin sulphates and keratin sulphates. An implication of this is that GAGs binding to tropoelastin can be adjusted based upon the content of 26A. Cross-linked tropoelastin would be expected to show differential binding to GAGs based on the relative amounts of SHEL vs. SHELδ26A.

In summary, these studies reveal that the 26A region is a functional glycosaminoglycan binding domain, which functions in intact tropoelastin. It is also active when isolated as a fusion entity yet displays no detectable structure in the absence of bound GAG. Furthermore, panel competition studies indicate a preference for those GAGs found in close association with the elastic fibre in the extracellular matrix.

Example 4: Construction of pSHELgamma, pSHEL31-36, PSHEL32-36 and pSHELgammaδ26A

pSHELgamma is derived from the pSHELgamma construct disclosed in WO94/74958. PSHEL31-36, pSHEL32-36 and pSHELgammaδ26A were derived from pSHELgamma. pSHELgamma was modified by introducing an oligonucleotide linker at the *Kpn*I site. This encoded a faster Xa cleavage site which could be utilised in subsequent constructs. PCR and site directed mutagenesis was then used to generate further, shorter forms which provided fusions with GST. Constructs were DNA sequenced for verification. Induced protein was isolated as GST-fusion proteins, which were subsequently bound to glutathione agarose. Protease cleavage was optional where fusion proteins were desired; otherwise the cleaved proteins and peptides were further purified by reverse phase HPLC.

## INDUSTRIAL APPLICATION

The derivatives and expression products of the invention are of use in *inter alia* the medical, pharmaceutical, veterinary and cosmetic fields.

It is to be understood that a reference herein to a prior art document does not constitute an admission that the document forms part of the common general knowledge in the art in Australia or in any other country.

In the claims which follow and in the preceding description of the invention, except where the context requires otherwise due to express language or necessary implication, the word "comprising" or grammatical variations thereof, is used in the sense of "including", i.e. the features specified may be associated with further features in various embodiments of the invention.

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SEQUENCE LISTING

(1) GENERAL INFORMATION:

(i) APPLICANT: WEISS, ANTHONY S
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(ii) TITLE OF INVENTION: TROPOELASTIN DERIVATIVES

(iii) NUMBER OF SEQUENCES: 15

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(E) COUNTRY: AUSTRALIA
(F) ZIP: 2060

(v) COMPUTER READABLE FORM:
(A) MEDIUM TYPE: Floppy disk
(B) COMPUTER: IBM PC compatible
(C) OPERATING SYSTEM: PC-DOS/MS-DOS
(D) SOFTWARE: PatentIn Release #1.0, Version #1.30

(vi) CURRENT APPLICATION DATA:
(A) APPLICATION NUMBER: AU
(B) FILING DATE:
(C) CLASSIFICATION:

(vii) PRIOR APPLICATION DATA:
(A) APPLICATION NUMBER: AU PO8117
(B) FILING DATE: 18-JUL-1997

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(2) INFORMATION FOR SEQ ID NO:1:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 2210 base pairs
(B) TYPE: nucleic acid
(C) STRANDEDNESS: double
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: DNA (genomic)

(iii) HYPOTHETICAL: YES

(iv) ANTI-SENSE: NO

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:1:

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GATCCATGGG TGGCGTTCCG GGTGCTATCC CGGGTGGCGT TCCGGGTGGT GTATTCTACC     60

CAGGCGCGGG TCTGGGTGCA CTGGGCGGTG GTGCGCTGGG CCCGGGTGGT AAACCGCTGA    120

AACCGGTTCC AGGCGGTCTG GCAGGTGCTG GTCTGGGTGC AGGTCTGGGC GCGTTCCCGG    180

CGGTTACCTT CCCGGGTGCT CTGGTTCCGG GTGGCGTTGC AGACGCAGCT GCTGCGTACA    240

AAGCGGCAAA GGCAGGTGCG GGTCTGGGCG GGGTACCAGG TGTTGGCGGT CTGGGTGTAT    300

CTGCTGGCGC AGTTGTTCCG CAGCCGGGTG CAGGTGTAAA ACCGGGCAAA GTTCCAGGTG    360

TTGGTCTGCC GGGCGTATAC CCGGGTGGTG TTCTGCCGGG CGCGCGTTTC CCAGGTGTTG    420

GTGTACTGCC GGGCGTTCCG ACCGGTGCAG GTGTTAAACC GAAGGCACCA GGTGTAGGCG    480

GCGCGTTCGC GGGTATCCCG GGTGTTGGCC CGTTCGGTGG TCCGCAGCCA GGCGTTCCGC    540

TGGGTTACCC GATCAAAGCG CCGAAGCTTC CAGGTGGCTA CGGTCTGCCG TACACCACCG    600

GTAAACTGCC GTACGGCTAC GGTCCGGGTG GCGTAGCAGG TGCTGCGGGT AAAGCAGGCT    660

ACCCAACCGG TACTGGTGTT GGTCCGCAGG CTGCTGCGGC AGCTGCGGCG AAGGCAGCAG    720

CAAAATTCGG CGCGGGTGCA GCGGGTGTTC TGCCGGGCGT AGGTGGTGCT GGCGTTCCGG    780

GTGTTCCAGG TGCGATCCCG GGCATCGGTG GTATCGCAGG CGTAGGTACT CCGGCGGCCG    840
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CTGCGGCTGC GGCAGCTGCG GCGAAAGCAG CTAAATACGG TGCGGCAGCA GGCCTGGTTC    900
CGGGTGGTCC AGGCTTCGGT CCGGGTGTTG TAGGCGTTCC GGGTGCTGGT GTTCCGGGCG    960
TAGGTGTTCC AGGTGCGGGC ATCCCGGTTG TACCGGGTGC AGGTATCCCG GGCGCTGCGG   1020
TTCCAGGTGT TGTATCCCCG GAAGCGGCAG CTAAGGCTGC TGCGAAAGCT GCGAAATACG   1080
GAGCTCGTCC GGGCGTTGGT GTTGGTGGCA TCCCGACCTA CGGTGTAGGT GCAGGCGGTT   1140
TCCCAGGTTT CGGCGTTGGT GTTGGTGGCA TCCCGGGTGT AGCTGGTGTT CCGTCTGTTG   1200
GTGGCGTACC GGGTGTTGGT GGCGTTCCAG GTGTAGGTAT CTCCCCGGAA GCGCAGGCAG   1260
CTGCGGCAGC TAAAGCAGCG AAGTACGGCG TTGGTACTCC GGCGGCAGCA GCTGCTAAAG   1320
CAGCGGCTAA AGCAGCGCAG TTCGGACTAG TTCCGGGCGT AGGTGTTGCG CCAGGTGTTG   1380
GCGTAGCACC GGGTGTTGGT GTTGCTCCGG GCGTAGGTCT GGCACCGGGT GTTGGCGTTG   1440
CACCAGGTGT AGGTGTTGCG CCGGGCGTTG GTGTAGCACC GGGTATCGGT CCGGGTGGCG   1500
TTGCGGCTGC TGCGAAATCT GCTGCGAAGG TTGCTGCGAA AGCGCAGCTG CGTGCAGCAG   1560
CTGGTCTGGG TGCGGGCATC CCAGGTCTGG GTGTAGGTGT TGGTGTTCCG GGCCTGGGTG   1620
TAGGTGCAGG GGTACCGGGC CTGGGTGTTG GTGCAGGCGT TCCGGGTTTC GGTGCTGGCG   1680
CGGACGAAGG TGTACGTCGT TCCCTGTCTC CAGAACTGCG TGAAGGTGAC CCGTCCTCTT   1740
CCCAGCACCT GCCGTCTACC CCGTCCTCTC CACGTGTTCC GGGCGCGCTG GCTGCTGCGA   1800
AAGCGGCGAA ATACGGTGCA GCGGTTCCGG GTGTACTGGG CGGTCTGGGT GCTCTGGGCG   1860
GTGTTGGTAT CCCGGGCGGT GTTGTAGGTG CAGGCCCAGC TGCAGCTGCT GCTGCGGCAA   1920
AGGCAGCGGC GAAAGCAGCT CAGTTCGGTC TGGTTGGTGC AGCAGGTCTG GGCGGTCTGG   1980
GTGTTGGCGG TCTGGGTGTA CCGGGCGTTG GTGGTCTGGG TGGCATCCCG CCGGCGGCGG   2040
CAGCTAAAGC GGCTAAATAC GGTGCAGCAG GTCTGGGTGG CGTTCTGGGT GGTGCTGGTC   2100
AGTTCCCACT GGGCGGTGTA GCGGCACGTC CGGGTTTCGG TCTGTCCCCG ATCTTCCCAG   2160
GCGGTGCATG CCTGGGTAAA GCTTGCGGCC GTAAACGTAA ATAATGATAG              2210
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(2) INFORMATION FOR SEQ ID NO:2:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 733 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: protein

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:2:

Ser Met Gly Gly Val Pro Gly Ala Ile Pro Gly Gly Val Pro Gly Gly
1 5 10 15

Val Phe Tyr Pro Gly Ala Gly Leu Gly Ala Leu Gly Gly Gly Ala Leu
20 25 30

Gly Pro Gly Gly Lys Pro Leu Lys Pro Val Pro Gly Gly Leu Ala Gly
35 40 45

Ala Gly Leu Gly Ala Gly Leu Gly Ala Phe Pro Ala Val Thr Phe Pro
50 55 60

Gly Ala Leu Val Pro Gly Gly Val Ala Asp Ala Ala Ala Ala Tyr Lys
65 70 75 80

Ala Ala Lys Ala Gly Ala Gly Leu Gly Gly Val Pro Gly Val Gly Gly
85 90 95

Leu Gly Val Ser Ala Gly Ala Val Val Pro Gln Pro Gly Ala Gly Val
100 105 110

Lys Pro Gly Lys Val Pro Gly Val Gly Leu Pro Gly Val Tyr Pro Gly
115 120 125

Gly Val Leu Pro Gly Ala Arg Phe Pro Gly Val Gly Val Leu Pro Gly
130 135 140

Val Pro Thr Gly Ala Gly Val Lys Pro Lys Ala Pro Gly Val Gly Gly
145 150 155 160

Ala Phe Ala Gly Ile Pro Gly Val Gly Pro Phe Gly Gly Pro Gln Pro

165 170 175

Gly Val Pro Leu Gly Tyr Pro Ile Lys Ala Pro Lys Leu Pro Gly Gly
180 185 190

Tyr Gly Leu Pro Tyr Thr Thr Gly Lys Leu Pro Tyr Gly Tyr Gly Pro
195 200 205

Gly Gly Val Ala Gly Ala Ala Gly Lys Ala Gly Tyr Pro Thr Gly Thr
210 215 220

Gly Val Gly Pro Gln Ala Ala Ala Ala Ala Ala Ala Lys Ala Ala Ala
225 230 235 240

Lys Phe Gly Ala Gly Ala Ala Gly Val Leu Pro Gly Val Gly Gly Ala
245 250 255

Gly Val Pro Gly Val Pro Gly Ala Ile Pro Gly Ile Gly Gly Ile Ala
260 265 270

Gly Val Gly Thr Pro Ala Ala Ala Ala Ala Ala Ala Ala Ala Ala Lys
275 280 285

Ala Ala Lys Tyr Gly Ala Ala Ala Gly Leu Val Pro Gly Gly Pro Gly
290 295 300

Phe Gly Pro Gly Val Val Gly Val Pro Gly Ala Gly Val Pro Gly Val
305 310 315 320

Gly Val Pro Gly Ala Gly Ile Pro Val Val Pro Gly Ala Gly Ile Pro
325 330 335

Gly Ala Ala Val Pro Gly Val Val Ser Pro Glu Ala Ala Ala Lys Ala
340 345 350

Ala Ala Lys Ala Ala Lys Tyr Gly Ala Arg Pro Gly Val Gly Val Gly
355 360 365

Gly Ile Pro Thr Tyr Gly Val Gly Ala Gly Gly Phe Pro Gly Phe Gly
370 375 380

Val Gly Val Gly Gly Ile Pro Gly Val Ala Gly Val Pro Ser Val Gly
385 390 395 400

Gly Val Pro Gly Val Gly Gly Val Pro Gly Val Gly Ile Ser Pro Glu
405 410 415

Ala Gln Ala Ala Ala Ala Ala Lys Ala Ala Lys Tyr Gly Val Gly Thr
420 425 430

Pro Ala Ala Ala Ala Ala Lys Ala Ala Ala Lys Ala Ala Gln Phe Gly
435 440 445

Leu Val Pro Gly Val Gly Val Ala Pro Gly Val Gly Val Ala Pro Gly
450 455 460

Val Gly Val Ala Pro Gly Val Gly Leu Ala Pro Gly Val Gly Val Ala
465 470 475 480

Pro Gly Val Gly Val Ala Pro Gly Val Gly Val Ala Pro Gly Ile Gly
485 490 495

Pro Gly Gly Val Ala Ala Ala Ala Lys Ser Ala Ala Lys Val Ala Ala
500 505 510

Lys Ala Gln Leu Arg Ala Ala Ala Gly Leu Gly Ala Gly Ile Pro Gly
515 520 525

Leu Gly Val Gly Val Gly Val Pro Gly Leu Gly Val Gly Ala Gly Val
530 535 540

Pro Gly Leu Gly Val Gly Ala Gly Val Pro Gly Phe Gly Ala Gly Ala
545 550 555 560

Asp Glu Gly Val Arg Arg Ser Leu Ser Pro Glu Leu Arg Glu Gly Asp
565 570 575

Pro Ser Ser Ser Gln His Leu Pro Ser Thr Pro Ser Ser Pro Arg Val
580 585 590

Pro Gly Ala Leu Ala Ala Ala Lys Ala Ala Lys Tyr Gly Ala Ala Val
595 600 605

Pro Gly Val Leu Gly Gly Leu Gly Ala Leu Gly Gly Val Gly Ile Pro
610 615 620

Gly Gly Val Val Gly Ala Gly Pro Ala Ala Ala Ala Ala Ala Ala Lys
625 630 635 640

Ala Ala Ala Lys Ala Ala Gln Phe Gly Leu Val Gly Ala Ala Gly Leu
645 650 655

Gly Gly Leu Gly Val Gly Gly Leu Gly Val Pro Gly Val Gly Gly Leu
660 665 670

Gly Gly Ile Pro Pro Ala Ala Ala Ala Lys Ala Ala Lys Tyr Gly Ala
675 680 685

Ala Gly Leu Gly Gly Val Leu Gly Gly Ala Gly Gln Phe Pro Leu Gly
690 695 700

Gly Val Ala Ala Arg Pro Gly Phe Gly Leu Ser Pro Ile Phe Pro Gly
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Gly Ala Cys Leu Gly Lys Ala Cys Gly Arg Lys Arg Lys
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(2) INFORMATION FOR SEQ ID NO:3:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 698 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: protein

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:3:

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Gly Gly Lys Pro Leu Lys Pro Val Pro Gly Gly Leu Ala Gly Ala Gly
35 40 45

Leu Gly Ala Gly Leu Gly Ala Phe Pro Ala Val Thr Phe Pro Gly Ala
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Leu Val Pro Gly Gly Val Ala Asp Ala Ala Ala Ala Tyr Lys Ala Ala
65 70 75 80

Lys Ala Gly Ala Gly Leu Gly Gly Val Pro Gly Val Gly Gly Leu Gly

85 90 95

Val Ser Ala Gly Ala Val Val Pro Gln Pro Gly Ala Gly Val Lys Pro
100 105 110

Gly Lys Val Pro Gly Val Gly Leu Pro Gly Val Tyr Pro Gly Gly Val
115 120 125

Leu Pro Gly Ala Arg Phe Pro Gly Val Gly Val Leu Pro Gly Val Pro
130 135 140

Thr Gly Ala Gly Val Lys Pro Lys Ala Pro Gly Val Gly Gly Ala Phe
145 150 155 160

Ala Gly Ile Pro Gly Val Gly Pro Phe Gly Gly Pro Gln Pro Gly Val
165 170 175

Pro Leu Gly Tyr Pro Ile Lys Ala Pro Lys Leu Pro Gly Gly Tyr Gly
180 185 190

Leu Pro Tyr Thr Thr Gly Lys Leu Pro Tyr Gly Tyr Gly Pro Gly Gly
195 200 205

Val Ala Gly Ala Ala Gly Lys Ala Gly Tyr Pro Thr Gly Thr Gly Val
210 215 220

Gly Pro Gln Ala Ala Ala Ala Ala Ala Ala Lys Ala Ala Ala Lys Phe
225 230 235 240

Gly Ala Gly Ala Ala Gly Val Leu Pro Gly Val Gly Gly Ala Gly Val
245 250 255

Pro Gly Val Pro Gly Ala Ile Pro Gly Ile Gly Gly Ile Ala Gly Val
260 265 270

Gly Thr Pro Ala Ala Ala Ala Ala Ala Ala Ala Ala Ala Lys Ala Ala
275 280 285

Lys Tyr Gly Ala Ala Ala Gly Leu Val Pro Gly Gly Pro Gly Phe Gly
290 295 300

Pro Gly Val Val Gly Val Pro Gly Ala Gly Val Pro Gly Val Gly Val
305 310 315 320

Pro Gly Ala Gly Ile Pro Val Val Pro Gly Ala Gly Ile Pro Gly Ala
325 330 335

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Ala Val Pro Gly Val Val Ser Pro Glu Ala Ala Ala Lys Ala Ala Ala
            340                 345                 350

Lys Ala Ala Lys Tyr Gly Ala Arg Pro Gly Val Gly Val Gly Gly Ile
        355                 360                 365

Pro Thr Tyr Gly Val Gly Ala Gly Gly Phe Pro Gly Phe Gly Val Gly
    370                 375                 380

Val Gly Gly Ile Pro Gly Val Ala Gly Val Pro Ser Val Gly Gly Val
385                 390                 395                 400

Pro Gly Val Gly Gly Val Pro Gly Val Gly Ile Ser Pro Glu Ala Gln
                405                 410                 415

Ala Ala Ala Ala Ala Lys Ala Ala Lys Tyr Gly Val Gly Thr Pro Ala
            420                 425                 430

Ala Ala Ala Ala Lys Ala Ala Ala Lys Ala Ala Gln Phe Gly Leu Val
        435                 440                 445

Pro Gly Val Gly Val Ala Pro Gly Val Gly Val Ala Pro Gly Val Gly
    450                 455                 460

Val Ala Pro Gly Val Gly Leu Ala Pro Gly Val Gly Val Ala Pro Gly
465                 470                 475                 480

Val Gly Val Ala Pro Gly Val Gly Val Ala Pro Gly Ile Gly Pro Gly
                485                 490                 495

Gly Val Ala Ala Ala Ala Lys Ser Ala Ala Lys Val Ala Ala Lys Ala
            500                 505                 510

Gln Leu Arg Ala Ala Ala Gly Leu Gly Ala Gly Ile Pro Gly Leu Gly
        515                 520                 525

Val Gly Val Gly Val Pro Gly Leu Gly Val Gly Ala Gly Val Pro Gly
    530                 535                 540

Leu Gly Val Gly Ala Gly Val Pro Gly Phe Gly Ala Val Pro Gly Ala
545                 550                 555                 560

Leu Ala Ala Ala Lys Ala Ala Lys Tyr Gly Ala Ala Val Pro Gly Val
                565                 570                 575
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Leu Gly Gly Leu Gly Ala Leu Gly Gly Val Gly Ile Pro Gly Gly Val
580 585 590

Val Gly Ala Gly Pro Ala Ala Ala Ala Ala Ala Ala Lys Ala Ala Ala
595 600 605

Lys Ala Ala Gln Phe Gly Leu Val Gly Ala Ala Gly Leu Gly Gly Leu
610 615 620

Gly Val Gly Gly Leu Gly Val Pro Gly Val Gly Gly Leu Gly Gly Ile
625 630 635 640

Pro Pro Ala Ala Ala Ala Lys Ala Ala Lys Tyr Gly Ala Ala Gly Leu
645 650 655

Gly Gly Val Leu Gly Gly Ala Gly Gln Phe Pro Leu Gly Gly Val Ala
660 665 670

Ala Arg Pro Gly Phe Gly Leu Ser Pro Ile Phe Pro Gly Gly Ala Cys
675 680 685

Leu Gly Lys Ala Cys Gly Arg Lys Arg Lys
690 695

(2) INFORMATION FOR SEQ ID NO:4:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 1983 base pairs
(B) TYPE: nucleic acid
(C) STRANDEDNESS: double
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: DNA (genomic)

(iii) HYPOTHETICAL: YES

(iv) ANTI-SENSE: NO

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:4:

ATGGGTGGCG TTCCGGGTGC TGTTCCGGGT GGCGTTCCGG GTGGTGTATT CTACCCAGGC 60

GCGGGTTTCG GTGCTGTTCC GGGTGGCGTT GCAGACGCAG CTGCTGCGTA CAAAGCGGCA 120

AAGGCAGGTG CGGGTCTGGG CGGGGTACCA GGTGTTGGCG GTCTGGGTGT ATCTGCTGGC 180

GCAGTTGTTC CGCAGCCGGG TGCAGGTGTA AAACCGGGCA AAGTTCCAGG TGTTGGTCTG 240

CCGGGCGTAT ACCCGGGTTT CGGTGCTGTT CCGGGCGCGC GTTTCCCAGG TGTTGGTGTA 300

CTGCCGGGCG TTCCGACCGG TGCAGGTGTT AAACCGAAGG CACCAGGTGT AGGCGGCGCG 360

TTCGCGGGTA TCCCGGGTGT TGGCCCGTTC GGTGGTCCGC AGCCAGGCGT TCCGCTGGGT 420

TACCCGATCA AAGCGCCGAA GCTTCCAGGT GGCTACGGTC TGCCGTACAC CACCGGTAAA 480

CTGCCGTACG GCTACGGTCC GGGTGGCGTA GCAGGTGCTG CGGGTAAAGC AGGCTACCCA 540

ACCGGTACTG GTGTTGGTCC GCAGGCTGCT GCGGCAGCTG CGGCGAAGGC AGCAGCAAAA 600

TTCGGCGCGG GTGCAGCGGG TTTCGGTGCT GTTCCGGGCG TAGGTGGTGC TGGCGTTCCG 660

GGTGTTCCAG GTGCGATCCC GGGCATCGGT GGTATCGCAG GCGTAGGTAC TCCGGCGGCC 720

GCTGCGGCTG CGGCAGCTGC GGCGAAAGCA GCTAAATACG GTGCGGCAGC AGGCCTGGTT 780

CCGGGTGGTC CAGGCTTCGG TCCGGGTGTT GTAGGCGTTC CGGGTTTCGG TGCTGTTCCG 840

GGCGTAGGTG TTCCAGGTGC GGGCATCCCG GTTGTACCGG GTGCAGGTAT CCCGGGCGCT 900

GCGGGTTTCG GTGCTGTATC CCCGGAAGCG GCAGCTAAGG CTGCTGCGAA AGCTGCGAAA 960

TACGGAGCTC GTCCGGGCGT TGGTGTTGGT GGCATCCCGA CCTACGGTGT AGGTGCAGGC 1020

GGTTTCCCAG GTTTCGGCGT TGGTGTTGGT GGCATCCCGG GTGTAGCTGG TGTTCCGTCT 1080

GTTGGTGGCG TACCGGGTGT TGGTGGCGTT CCAGGTGTAG GTATCTCCCC GGAAGCGCAG 1140

GCAGCTGCGG CAGCTAAAGC AGCGAAGTAC GGCGTTGGTA CTCCGGCGGC AGCAGCTGCT 1200

AAAGCAGCGG CTAAAGCAGC GCAGTTCGGA CTAGTTCCGG GCGTAGGTGT TGCGCCAGGT 1260

GTTGGCGTAG CACCGGGTGT TGGTGTTGCT CCGGGCGTAG GTCTGGCACC GGGTGTTGGC 1320

GTTGCACCAG GTGTAGGTGT TGCGCCGGGC GTTGGTGTAG CACCGGGTAT CGGTCCGGGT 1380

GGCGTTGCGG CTGCTGCGAA ATCTGCTGCG AAGGTTGCTG CGAAAGCGCA GCTGCGTGCA 1440

GCAGCTGGTC TGGGTGCGGG CATCCCAGGT CTGGGTGTAG GTGTTGGTGT TCCGGGCCTG 1500

GGTGTAGGTG CAGGGGTACC GGGCCTGGGT GTTGGTGCAG GCGTTCCGGG TTTCGGTGCT 1560

GTTCCGGGCG CGCTGGCTGC TGCGAAAGCG GCGAAATACG GTGCTGTTCC GGGTGTACTG 1620

GGCGGTCTGG GTGCTCTGGG CGGTGTTGGT ATCCCGGGCG GTGTTGTAGG TGCAGGCCCA 1680

GCTGCAGCTG CTGCTGCGGC AAAGGCAGCG GCGAAAGCAG CTCAGTTCGG TCTGGTTGGT 1740

GCAGCAGGTC TGGGCGGTCT GGGTGTTGGC GGTCTGGGTG TACCGGGCGT TGGTGGTCTG 1800

GGTGGCATCC CGCCGGCGGC GGCAGCTAAA GCGGCTAAAT ACGGTGCAGC AGGTCTGGGT 1860

GGCGTTCTGG GTGGTGCTGG TCAGTTCCCA CTGGGCGGTG TAGCGGCACG TCCGGGTTTC 1920

GGTCTGTCCC CGATCTTCCC AGGCGGTGCA TGCCTGGGTA AAGCTTGCGG CCGTAAACGT 1980

AAA 1983

(2) INFORMATION FOR SEQ ID NO:5:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 660 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: protein

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:5:

Met Gly Gly Val Pro Gly Ala Val Pro Gly Gly Val Pro Gly Gly Val
1 5 10 15

Phe Tyr Pro Gly Ala Gly Phe Gly Ala Val Pro Gly Gly Val Ala Asp
20 25 30

Ala Ala Ala Ala Tyr Lys Ala Ala Lys Ala Gly Ala Gly Leu Gly Gly
35 40 45

Val Pro Gly Val Gly Gly Leu Gly Val Ser Ala Gly Ala Val Val Pro
50 55 60

Gln Pro Gly Ala Gly Val Lys Pro Gly Lys Val Pro Gly Val Gly Leu
65 70 75 80

Pro Gly Val Tyr Pro Gly Phe Gly Ala Val Pro Gly Ala Arg Phe Pro
85 90 95

Gly Val Gly Val Leu Pro Gly Val Pro Thr Gly Ala Gly Val Lys Pro
100 105 110

Lys Ala Pro Gly Val Gly Gly Ala Phe Ala Gly Ile Pro Gly Val Gly
115 120 125

Pro Phe Gly Gly Pro Gln Pro Gly Val Pro Leu Gly Tyr Pro Ile Lys
130 135 140

Ala Pro Lys Leu Pro Gly Gly Tyr Gly Leu Pro Tyr Thr Thr Gly Lys
145 150 155 160

Leu Pro Tyr Gly Tyr Gly Pro Gly Gly Val Ala Ala Ala Gly Lys Ala
165 170 175

Gly Tyr Pro Thr Gly Thr Gly Val Gly Pro Gln Ala Ala Ala Ala Ala
180 185 190

Ala Ala Lys Ala Ala Ala Lys Phe Gly Ala Gly Ala Ala Gly Phe Gly
195 200 205

Ala Val Pro Gly Val Gly Gly Ala Gly Val Pro Gly Val Pro Gly Ala
210 215 220

Ile Pro Gly Ile Gly Gly Ile Ala Gly Val Gly Thr Pro Ala Ala Ala
225 230 235 240

Ala Ala Ala Ala Ala Ala Ala Lys Ala Ala Lys Tyr Gly Ala Ala Ala
245 250 255

Gly Leu Val Pro Gly Gly Pro Gly Phe Gly Pro Gly Val Val Gly Val
260 265 270

Pro Gly Phe Gly Ala Val Pro Gly Val Gly Val Pro Gly Ala Gly Ile
275 280 285

Pro Val Val Pro Gly Ala Gly Ile Pro Gly Ala Ala Gly Phe Gly Ala
290 295 300

Val Ser Pro Glu Ala Ala Ala Lys Ala Ala Ala Lys Ala Ala Lys Tyr

305 310 315 320

Gly Ala Arg Pro Gly Val Gly Val Gly Gly Ile Pro Thr Tyr Gly Val
325 330 335

Gly Ala Gly Phe Phe Pro Gly Phe Gly Val Gly Val Gly Gly Ile Pro
340 345 350

Gly Val Ala Gly Val Pro Ser Val Gly Gly Val Pro Gly Val Gly Gly
355 360 365

Val Pro Gly Val Gly Ile Ser Pro Glu Ala Gln Ala Ala Ala Ala Ala
370 375 380

Lys Ala Ala Lys Tyr Gly Val Gly Thr Pro Ala Ala Ala Ala Ala Lys
385 390 395 400

Ala Ala Ala Lys Ala Ala Gln Phe Gly Leu Val Pro Gly Val Gly Val
405 410 415

Ala Pro Gly Val Gly Val Ala Pro Gly Val Gly Val Ala Pro Gly Val
420 425 430

Gly Leu Ala Pro Gly Val Gly Val Ala Pro Gly Val Gly Val Ala Pro
435 440 445

Gly Val Gly Val Ala Pro Gly Ile Gly Pro Gly Gly Val Ala Ala Ala
450 455 460

Ala Lys Ser Ala Ala Lys Val Ala Ala Lys Ala Gln Leu Arg Ala Ala
465 470 475 480

Ala Gly Leu Gly Ala Gly Ile Pro Gly Leu Gly Val Gly Val Gly Val
485 490 495

Pro Gly Leu Gly Val Gly Ala Gly Val Pro Gly Leu Gly Val Gly Ala
500 505 510

Gly Val Pro Gly Phe Gly Ala Val Pro Gly Ala Leu Ala Ala Ala Lys
515 520 525

Ala Ala Lys Tyr Gly Ala Val Pro Gly Val Leu Gly Gly Leu Gly Ala
530 535 540

Leu Gly Gly Val Gly Ile Pro Gly Gly Val Val Gly Ala Gly Pro Ala
545 550 555 560

Ala Ala Ala Ala Ala Ala Lys Ala Ala Ala Lys Ala Ala Gln Phe Gly
565 570 575

Leu Val Gly Ala Ala Gly Leu Gly Gly Leu Gly Val Gly Gly Leu Gly
580 585 590

Val Pro Gly Val Gly Gly Leu Gly Gly Ile Pro Pro Ala Ala Ala Ala
595 600 605

Lys Ala Ala Lys Tyr Gly Ala Ala Gly Leu Gly Gly Val Leu Gly Gly
610 615 620

Ala Gly Gln Phe Pro Leu Gly Gly Val Ala Ala Arg Pro Gly Phe Gly
625 630 635 640

Leu Ser Pro Ile Phe Pro Gly Gly Ala Cys Leu Gly Lys Ala Cys Gly
645 650 655

Arg Lys Arg Lys
660

(2) INFORMATION FOR SEQ ID NO:6:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 441 base pairs
(B) TYPE: nucleic acid
(C) STRANDEDNESS: double
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: DNA (genomic)

(iii) HYPOTHETICAL: YES

(iv) ANTI-SENSE: NO

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:6:

TCCGCCATGG GAGGTGTTCC GGGCGCGCTG GCTGCTGCGA AAGCGGCGAA ATACGGTGCA 60

GCGGTTCCGG GTGTACTGGG CGGTCTGGGT GCTCTGGGCG GTGTTGGTAT CCCGGGCGGT 120

GTTGTAGGTG CAGGCCCAGC TGCAGCTGCT GCTGCGGCAA AGGCAGCGGC GAAAGCAGCT 180

CAGTTCGGTC TGGTTGGTGC AGCAGGTGTG GGCGGTCTGG GTGTTGGCGG TCTGGGTGTA 240

CCGGGCGTTG GTGGTCTGGG TGGCATCCCG CCGGCGGCGG CAGCTAAAGC GGCTAAATAC 300

GGTGCAGCAG GTCTGGGTGG CGTTCTGGGT GGTGCTGGTC AGTTCCCACT GGGCGGTGTA 360

GCGGCACGTC CGGGTTTCGG TCTGTCCCCG ATCTTCCCAG GCGGTGCATG CCTGGGTAAA 420

GCTTGCGGCC GTAAACGTAA A 441

(2) INFORMATION FOR SEQ ID NO:7:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 147 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: protein

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:7:

Ser Ala Met Gly Gly Val Pro Gly Ala Leu Ala Ala Ala Lys Ala Ala
1 5 10 15

Lys Tyr Gly Ala Ala Val Pro Gly Val Leu Gly Gly Leu Gly Ala Leu
20 25 30

Gly Gly Val Gly Ile Pro Gly Gly Val Val Gly Ala Gly Pro Ala Ala
35 40 45

Ala Ala Ala Ala Ala Lys Ala Ala Ala Lys Ala Ala Gln Phe Gly Leu
50 55 60

Val Gly Ala Ala Gly Leu Gly Gly Leu Gly Val Gly Gly Leu Gly Val
65 70 75 80

Pro Gly Val Gly Gly Leu Gly Gly Ile Pro Pro Ala Ala Ala Ala Lys
85 90 95

Ala Ala Lys Tyr Gly Ala Ala Gly Leu Gly Gly Val Leu Gly Gly Ala
100 105 110

Gly Gln Phe Pro Leu Gly Gly Val Ala Ala Arg Pro Gly Phe Gly Leu
115 120 125

Ser Pro Ile Phe Pro Gly Gly Ala Cys Leu Gly Lys Ala Cys Gly Arg
130 135 140

Lys Arg Lys
145

(2) INFORMATION FOR SEQ ID NO:8:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 600 base pairs
(B) TYPE: nucleic acid
(C) STRANDEDNESS: double
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: DNA (genomic)

(iii) HYPOTHETICAL: YES

(iv) ANTI-SENSE: NO

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:8:

TCCGCCATGG GAGCTCTGGT AGGCCTGGGC GTACCGGGCC TGGGTGTTGG TGCAGGCGTT 60

CCGGGTTTCG GTGCTGGCGC GGACGAAGGT GTACGTCGTT CCCTGTCTCC AGAACTGCGT 120

GAAGGTGACC CGTCCTCTTC CCAGCACCTG CCGTCTACCC CGTCCTCTCC ACGTGTTCCG 180

GGCGCGCTGG CTGCTGCGAA AGCGGCGAAA TACGGTGCAG CGGTTCCGGG TGTACTGGGC 240

GGTCTGGGTG CTCTGGGCGG TGTTGGTATC CCGGGCGGTG TTGTAGGTGC AGGCCCAGCT 300

GCAGCTGCTG CTGCGGCAAA GGCAGCGGCG AAAGCAGCTC AGTTCGGTCT GGTTGGTGCA 360

GCAGGTCTGG GCGGTCTGGG TGTTGGCGGT CTGGGTGTAC CGGGCGTTGG TGGTCTGGGT 420

GGCATCCCGC CGGCGGCGGC AGCTAAAGCG GCTAAATACG GTGCAGCAGG TCTGGGTGGC 480

GTTCTGGGTG GTGCTGGTCA GTTCCCACTG GGCGGTGTAG CGGCACGTCC GGGTTTCGGT 540

CTGTCCCCGA TCTTCCCAGG CGGTGCATGC CTGGGTAAAG CTTGCGGCCG TAAACGTAAA 600

(2) INFORMATION FOR SEQ ID NO:9:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 200 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: protein

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:9:

Ser Ala Met Gly Ala Leu Val Gly Leu Gly Val Pro Gly Leu Gly Val
1 5 10 15

Gly Ala Gly Val Pro Gly Phe Gly Ala Gly Ala Asp Glu Gly Val Arg
20 25 30

Arg Ser Leu Ser Pro Glu Leu Arg Glu Gly Asp Pro Ser Ser Ser Gln
35 40 45

His Leu Pro Ser Thr Pro Ser Ser Pro Arg Val Pro Gly Ala Leu Ala
50 55 60

Ala Ala Lys Ala Ala Lys Tyr Gly Ala Ala Val Pro Gly Val Leu Gly
65 70 75 80

Gly Leu Gly Ala Leu Gly Gly Val Gly Ile Pro Gly Gly Val Val Gly
85 90 95

Ala Gly Pro Ala Ala Ala Ala Ala Ala Ala Lys Ala Ala Ala Lys Ala
100 105 110

Ala Gln Phe Gly Leu Val Gly Ala Ala Gly Leu Gly Gly Leu Gly Val
115 120 125

Gly Gly Leu Gly Val Pro Gly Val Gly Gly Leu Gly Gly Ile Pro Pro
130 135 140

```
Ala Ala Ala Ala Lys Ala Ala Lys Tyr Gly Ala Ala Gly Leu Gly Gly
145                 150                 155                 160

Val Leu Gly Gly Ala Gly Gln Phe Pro Leu Gly Gly Val Ala Ala Arg
                165                 170                 175

Pro Gly Phe Gly Leu Ser Pro Ile Phe Pro Gly Gly Ala Cys Leu Gly
            180                 185                 190

Lys Ala Cys Gly Arg Lys Arg Lys
        195                 200
```

(2) INFORMATION FOR SEQ ID NO:10:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 60 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: protein

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:10:

```
Gly Ile Pro Pro Ala Ala Ala Ala Lys Ala Ala Lys Tyr Gly Ala Ala
1               5                   10                  15

Gly Leu Gly Gly Val Leu Gly Gly Ala Gly Gln Phe Pro Leu Gly Gly
            20                  25                  30

Val Ala Ala Arg Pro Gly Phe Gly Leu Ser Pro Ile Phe Pro Gly Gly
        35                  40                  45

Ala Cys Leu Gly Lys Ala Cys Gly Arg Lys Arg Lys
    50                  55                  60
```

(2) INFORMATION FOR SEQ ID NO:11:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 47 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: protein

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:11:

Gly Ala Ala Gly Leu Gly Gly Val Leu Gly Gly Ala Gly Gln Phe Pro
1 5 10 15

Leu Gly Gly Val Ala Ala Arg Pro Gly Phe Gly Leu Ser Pro Ile Phe
20 25 30

Pro Gly Gly Ala Cys Leu Gly Lys Ala Cys Gly Arg Lys Arg Lys
35 40 45

(2) INFORMATION FOR SEQ ID NO:12:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 34 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: protein

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:12:

Gly Ala Asp Glu Gly Val Arg Arg Ser Leu Ser Pro Glu Leu Arg Glu
1 5 10 15

Gly Asp Pro Ser Ser Ser Gln His Leu Pro Ser Thr Pro Ser Ser Pro
20 25 30

Arg Val

(2) INFORMATION FOR SEQ ID NO:13:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 34 amino acids
(B) TYPE: amino acid

(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: protein

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:13:

```
Gly Ala Asp Glu Gly Val Arg Arg Ser Leu Ser Pro Glu Leu Arg Glu
1               5                   10                  15

Gly Asp Pro Ser Ser Ser Gln His Leu Pro Ser Thr Pro Ser Ser Pro
            20                  25                  30

Arg Phe
```

(2) INFORMATION FOR SEQ ID NO:14:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 216 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: protein

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:14:

```
Ala Ala Ala Gly Leu Gly Ala Gly Ile Pro Gly Leu Gly Val Gly Val
1               5                   10                  15

Gly Val Pro Gly Leu Gly Val Gly Ala Gly Val Pro Gly Leu Gly Val
            20                  25                  30

Gly Ala Gly Val Pro Gly Phe Gly Ala Gly Ala Asp Glu Gly Val Arg
        35                  40                  45

Arg Ser Leu Ser Pro Glu Leu Arg Glu Gly Asp Pro Ser Ser Ser Gln
    50                  55                  60
```

His Leu Pro Ser Thr Pro Ser Ser Pro Arg Val Pro Gly Ala Leu Ala
65 70 75 80

Ala Ala Lys Ala Ala Lys Tyr Gly Ala Ala Val Pro Gly Val Leu Gly
85 90 95

Gly Leu Gly Ala Leu Gly Gly Val Gly Ile Pro Gly Gly Val Val Gly
100 105 110

Ala Gly Pro Ala Ala Ala Ala Ala Ala Ala Lys Ala Ala Ala Lys Ala
115 120 125

Ala Gln Phe Gly Leu Val Gly Ala Ala Gly Leu Gly Gly Leu Gly Val
130 135 140

Gly Gly Leu Gly Val Pro Gly Val Gly Gly Leu Gly Gly Ile Pro Pro
145 150 155 160

Ala Ala Ala Ala Lys Ala Ala Lys Tyr Gly Ala Ala Gly Leu Gly Gly
165 170 175

Val Leu Gly Gly Ala Gly Gln Phe Pro Leu Gly Gly Val Ala Ala Arg
180 185 190

Pro Gly Phe Gly Leu Ser Pro Ile Phe Pro Gly Gly Ala Cys Leu Gly
195 200 205

Lys Ala Cys Gly Arg Lys Arg Lys
210 215

(2) INFORMATION FOR SEQ ID NO:15:

(i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 183 amino acids
(B) TYPE: amino acid
(C) STRANDEDNESS:
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: protein

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:15:

Ala Ala Ala Gly Leu Gly Ala Gly Ile Pro Gly Leu Gly Val Gly Val

```
1               5                   10                  15

Gly Val Pro Gly Leu Gly Val Gly Ala Gly Val Pro Gly Leu Gly Val
            20                  25                  30

Gly Ala Gly Val Pro Gly Phe Gly Ala Val Pro Gly Ala Leu Ala Ala
        35                  40                  45

Ala Lys Ala Ala Lys Tyr Gly Ala Ala Val Pro Gly Val Leu Gly Gly
    50                  55                  60

Leu Gly Ala Leu Gly Gly Val Gly Ile Pro Gly Gly Val Val Gly Ala
65                  70                  75                  80

Gly Pro Ala Ala Ala Ala Ala Ala Ala Lys Ala Ala Ala Lys Ala Ala
                85                  90                  95

Gln Phe Gly Leu Val Gly Ala Ala Gly Leu Gly Gly Leu Gly Val Gly
            100                 105                 110

Gly Leu Gly Val Pro Gly Val Gly Gly Leu Gly Gly Ile Pro Pro Ala
        115                 120                 125

Ala Ala Ala Lys Ala Ala Lys Tyr Gly Ala Ala Gly Leu Gly Gly Val
    130                 135                 140

Leu Gly Gly Ala Gly Gln Phe Pro Leu Gly Gly Val Ala Ala Arg Pro
145                 150                 155                 160

Gly Phe Gly Leu Ser Pro Ile Phe Pro Gly Gly Ala Cys Leu Gly Lys
                165                 170                 175

Ala Cys Gly Arg Lys Arg Lys
            180
```

PCT/AU98/00564
Received 04 November 1999



THE CLAIMS

1. A human tropoelastin derivative or an amino acid sequence variant thereof, wherein the derivative or variant has elastin-like properties.

2. A human tropoelastin derivative or an amino acid sequence variant thereof, wherein the derivative or variant has macro-molecular binding properties.

3. A derivative or variant thereof according to claim 2 wherein the macro-molecular binding properties include the ability to bind glycosyaminoglycans.

4. A human tropoelastin derivative or an amino acid sequence variant thereof, wherein the derivative or variant has elastin-like properties and macro-molecular binding properties.

5. A polynucleotide encoding a derivative or variant thereof of any one of claims 1 to 4.

6. A tropoelastin derivative which has the amino acid sequence of SHELδmodified.

7. A tropoelastin derivative which has the amino acid sequence shown in SEQ ID NO: 5.

8. A polynucleotide encoding a tropoelastin derivative according to claims 6 or 7.

9. A polynucleotide which has the nucleotide sequence shown in SEQ ID NO: 4.

10. A synthetic polynucleotide encoding a tropoelastin derivative which has the amino acid sequence of SHELδ26A.

11. A synthetic polynucleotide which has the nucleotide sequence of from nucleotide position 1 to 1676 contiguous with the sequence of from nucleotide position 1775 to 2210 of SEQ ID NO: 1.

12. A tropoelastin derivative which has the amino acid sequence of SHELgamma.

13. A tropoelastin derivative which has the amino acid sequence shown in SEQ ID NO: 9.

14. A polynucleotide encoding a tropoelastin derivative according to claim 12 or 13.

15. A polynucleotide which has the nucleotide sequence shown in SEQ ID NO: 8.

16. A tropoelastin derivative which has the amino acid sequence of SHELgamma excluding exon 26A.

17. A tropoelastin derivative which has the amino acid sequence shown in SEQ ID NO: 7.

18. A polynucleotide encoding a tropoelastin derivative according to claim 16 or 17.

19. A polynucleotide which has the nucleotide sequence shown in SEQ ID NO: 6.

PCT/AU98/00564
Received 04 November 1999



20. A tropoelastin derivative which has the amino acid sequence of SHEL31-36.

21. A tropoelastin derivative which has the amino acid sequence shown in SEQ ID NO: 10.

22. A polynucleotide encoding a tropoelastin derivative according to claim 20 or 21.

23. A polynucleotide which has the nucleotide sequence shown in nucleotide position 2022 to 2210 of SEQ ID NO: 1.

24. A tropoelastin derivative which has the amino acid sequence of SHEL32-36.

25. A tropoelastin derivative which has the amino acid sequence shown in SEQ ID NO: 11.

26. A polynucleotide encoding a tropoelastin derivative according to claim 23 or 24.

27. A polynucleotide which has the nucleotide sequence shown in nucleotide position 2061 to 2210 of SEQ ID NO: 1.

28. A tropoelastin derivative which has the amino acid sequence of peptide 26A.

29. A tropoelastin derivative which has the amino acid sequence shown in SEQ ID NO: 12 or SEQ ID NO: 13.

30. A polynucleotide encoding a tropoelastin derivative according to claim 28 or 29.

PCT/AU98/00564
Received 04 November 1999



31. A polynucleotide which has the nucleotide sequence shown in nucleotide position 1667 to 1774 of SEQ ID NO: 1.

32. A tropoelastin derivative which has the amino acid sequence of SHEL26-36.

33. A tropoelastin derivative which has the amino acid sequence shown in SEQ ID NO: 14.

34. A polynucleotide encoding a tropoelastin derivative according to claim 32 or 33.

35. A polynucleotide which has the nucleotide sequence shown in nucleotide position 1554 to 2210 of SEQ ID NO: 1.

36. A tropoelastin derivative which has the amino acid sequence of SHEL26-36 excluding exon 26A.

37. A tropoelastin derivative which has the amino acid sequence shown in SEQ ID NO: 15.

38. A polynucleotide encoding a tropoelastin derivative according to claim 36 or 37.

39. A polynucleotide which has the nucleotide sequence shown in nucleotide position 1554 to 1676 contiguous with the sequence of from nucleotide position 1776 to 2210 of SEQ ID NO: 1.

40. A vector comprising a polynucleotide according to any one of claims 5, 8, 9, 14, 15, 18, 19, 22, 23, 26, 27, 30, 31, 34, 35, 38, 39, or a synthetic

PCT/AU98/00564
Received 04 November 1999



polynucleotide according to claim 10 or 11.

41. The vector according to claim 40 wherein the polynucleotide or synthetic polynucleotide is operatively linked to a promoter to enhancer regulatory sequence.

42. The vector according to claim 40 or 41 wherein the polynucleotide or synthetic polynucleotide is operatively linked to a nucleotide sequence, the nucleotide sequence encoding a further amino acid sequence.

43. A cell containing a vector according to any one of claims 40 to 42.

44. A method for producing a derivative of tropoelastin, the method comprising:

(a) providing a vector according to any one of claims 40 to 42;
(b) introducing the vector into a cell;
(c) maintaining the cell in conditions suitable for expression of the vector; and
(d) isolating the tropoelastin derivative.

45. A tropoelastin derivative produced by the method of claim 44.

46. A transgenic non-human animal containing a vector according to any one of claims 40 to 42, or a polynucleotide according to any one of claims 5, 8, 9, 14, 15, 18, 19, 22, 23, 26, 27, 30, 31, 34, 35, 38, 39, or a synthetic polynucleotide according to claim 10 or 11.

47. A tropoelastin derivative produced by a transgenic animal according to claim 46.

48. A method for producing a tropoelastin derivative according to any one of claims 1-4, 6, 7, 12, 13, 16, 17, 20, 21, 24, 25, 28, 29, 32, 33, 36 or 37, the method comprising producing the tropoelastin derivative by solid-phase peptide synthesis.

49. A tropoelastin derivative produced by the method of claim 48.

50. A formulation comprising at least one tropoelastin derivative according to any one of claims 1-4, 6, 7, 12, 13, 16, 17, 20, 21, 24, 25, 28, 29, 32, 33, 36, 37, 45 or 47, together with a pharmaceutically acceptable carrier or diluent.

51. An expression product comprising a tropoelastin derivative according to any one of claims 1-4, 6, 7, 12, 13, 16, 17, 20, 21, 24, 25, 28, 29, 32, 33, 36, 37, 45 or 47, and a further amino acid sequence.

52. An expression product according to claim 51 wherein the tropoelastin derivative has the amino acid sequence of peptide 26A.

53. A polynucleotide encoding an expression product according to claims 51 or 52.

54. A vector comprising the polynucleotide according to claim 53.

PCT/AU98/00564
Received 04 November 1999



55. A cell containing a vector according to claim 54.

56. A method for producing an expression product according to claim 51 or 52, the method comprising:

(a) providing a vector according to claim 54;

(b) introducing the vector into a cell;

(c) maintaining the cell in conditions suitable for expression of the vector; and

(d) isolating the expression product.

57. An expression product produced by the method of claim 56.

58 A transgenic non-human animal containing a vector according to claim 54 or a polynucleotide according to claim 53.

59. An expression product produced by a transgenic animal according to claim 58.

60. A formulation comprising at least one expression product according to any of claims 51, 52, 57 or 59, together with a pharmaceutically acceptable carrier or diluent.

61. A hybrid molecule comprising a biological polymer wherein the polymer is linked to a tropoelastin derivative comprising the amino acid sequence of peptide 26A.

62. A hybrid molecule according to claim 61

wherein the biological polymer is a protein.

63. A hybrid molecule according to claim 62 wherein the protein is selected from the group consisting of cytokines, growth factors and antibodies.

64. A hybrid molecule according to claim 61 wherein the biological polymer is selected from the group consisting of lipids, sugars and nucleic acids.

65. A polynucleotide sequence encoding a hybrid molecule according to claim 62.

66. A vector comprising a polynucleotide sequence according to claim 65.

67. A cell containing a vector according to claim 66.

68. A method for producing a hybrid molecule according to claim 62, the method comprising:

(a) providing a vector according to claim 66;

(b) introducing the vector into a cell;

(c) maintaining the cell in conditions suitable for expression of the vector; and

(d) isolating the hybrid molecule.

69. A hybrid molecule produced by the method of claim 68.

70. A transgenic non-human animal containing a vector according to claim 66 or a polynucleotide according

PCT/AU98/00564
Received 04 November 1999



to claim 65.

71. A hybrid molecule produced by a transgenic animal according to claim 70.

72. A hybrid molecule comprising a synthetic polymer linked to peptide 26A.

73. A formulation comprising at least one hybrid molecule according to any of claims 61-63, 69, 71 and 72, together with a pharmaceutically acceptable carrier or diluent.

74. A cross linked complex, the complex comprising at least one of the following:

(i) at least one derivative according to any one of claims 1-4, 6, 7, 12, 13, 16, 17, 20, 21, 24, 25, 28, 29, 32, 33, 36, 37, 45 or 47;

(ii) at least expression product according to any one of claims 51, 52, 56 or 59; and

(iii) least one hybrid molecule according to any one of claims 61-63, 69, 71 or 72.

75. An implant, the implant comprising at least one of the following:

(i) at least one derivative according to any one of claims 1-4, 6, 7, 12, 13, 16, 17, 20, 21, 24, 25, 28, 29, 32, 33, 36, 37, 45 or 47;

(ii) at least one expression product according to any one of claims 51,

PCT/AU98/00564
Received 04 November 1999



52, 56 or 59; and

(iii) at least one hybrid molecule according to any one of claims 61-63, 69, 71 or 72.

76. A method of imparting glycosaminoglycan binding activity to a biological polymer comprising the step of linking a tropoelastin derivative comprising the amino acid sequence of peptide 26A to the biological polymer.

77. A method of deleting glycosaminoglycan binding activity from a biological polymer comprising the step of deleting a tropoelastin derivative comprising the amino acid sequence of peptide 26A from the biological polymer.

78 The method of claim 64 or 65 wherein the biological polymer is a protein.

79. A formulation comprising a tropoelastin derivative and a synthetic or biological polymer.

```
1   GATCCATGGGTGGCGTTCCGGGTGCTATCCCGGGTGGCGTTCCGGGTGGTGTATTCTACC   60
        GTACCCACCGCAAGGCCCACGATAGGGCCCACCGCAAGGCCCACCACATAAGATGG

     S  M  G  G  V  P  G  A  I  P  G  G  V  P  G  G  V  F  Y  P

61  CAGGCGCGGGTCTGGGTGCACTGGGCGGTGGTGCGCTGGGCCCGGGTGGTAAACCGCTGA   120
    GTCCGCGCCCAGACCCACGTGACCCGCCACCACGCGACCCGGGCCCACCATTTGGCGACT

     G  A  G  L  G  A  L  G  G  G  A  L  G  P  G  G  K  P  L  K

121 AACCGGTTCCAGGCGGTCTGGCAGGTGCTGGTCTGGGTGCAGGTCTGGGCGCGTTCCCGG   180
    TTGGCCAAGGTCCGCCAGACCGTCCACGACCAGACCCACGTCCAGACCCGCGCAAGGGCC

     P  V  P  G  G  L  A  G  A  G  L  G  A  G  L  G  A  F  P  A

181 CGGTTACCTTCCCGGGTGCTCTGGTTCCGGGTGGCGTTGCAGACGCAGCTGCTGCGTACA   240
    GCCAATGGAAGGGCCCACGAGACCAAGGCCCACCGCAACGTCTGCGTCGACGACGCATGT

     V  T  F  P  G  A  L  V  P  G  G  V  A  D  A  A  A  A  Y  K

241 AAGCGGCAAAGGCAGGTGCGGGTCTGGGCGGGGTACCAGGTGTTGGCGGTCTGGGTGTAT   300
    TTCGCCGTTTCCGTCCACGCCCAGACCCGCCCCATGGTCCACAACCGCCAGACCCACATA

     A  A  K  A  G  A  G  L  G  G  V  P  G  V  G  G  L  G  V  S

301 CTGCTGGCGCAGTTGTTCCGCAGCCGGGTGCAGGTGTAAAACCGGGCAAAGTTCCAGGTG   360
    GACGACCGCGTCAACAAGGCGTCGGCCCACGTCCACATTTTGGCCCGTTTCAAGGTCCAC

     A  G  A  V  V  P  Q  P  G  A  G  V  K  P  G  K  V  P  G  V

361 TTGGTCTGCCGGGCGTATACCCGGGTGGTGTTCTGCCGGGCGCGCGTTTCCCAGGTGTTG   420
    AACCAGACGGCCCGCATATGGGCCCACCACAAGACGGCCCGCGCGCAAAGGGTCCACAAC

     G  L  P  G  V  Y  P  G  G  V  L  P  G  A  R  F  P  G  V  G
```

Figure 1(1)

421 GTGTACTGCCGGGCGTTCCGACCGGTGCAGGTGTTAAACCGAAGGCACCAGGTGTAGGCG 480
CACATGACGGCCCGCAAGGCTGGCCACGTCCACAATTTGGCTTCCGTGGTCCACATCCGC
V L P G V P T G A G V K P K A P G V G G

481 GCGCGTTCGCGGGTATCCCGGGTGTTGGCCCGTTCGGTGGTCCGCAGCCAGGCGTTCCGC 540
CGCGCAAGCGCCCATAGGGCCCACAACCGGGCAAGCCACCAGGCGTCGGTCCGCAAGGCG
A F A G I P G V G P F G G P Q P G V P L

541 TGGGTTACCCGATCAAAGCGCCGAAGCTTCCAGGTGGCTACGGTCTGCCGTACACCACCG 600
ACCCAATGGGCTAGTTTCGCGGCTTCGAAGGTCCACCGATGCCAGACGGCATGTGGTGGC
G Y P I K A P K L P G G Y G L P Y T T G

601 GTAAACTGCCGTACGGCTACGGTCCGGGTGGCGTAGCAGGTGCTGCGGGTAAAGCAGGCT 660
CATTTGACGGCATGCCGATGCCAGGCCCACCGCATCGTCCACGACGCCCATTTCGTCCGA
K L P Y G Y G P G G V A G A A G K A G Y

661 ACCCAACCGGTACTGGTGTTGGTCCGCAGGCTGCTGCGGCAGCTGCGGCGAAGGCAGCAG 720
TGGGTTGGCCATGACCACAACCAGGCGTCCGACGACGCCGTCGACGCCGCTTCCGTCGTC
P T G T G V G P Q A A A A A A A K A A A

721 CAAAATTCGGCGCGGGTGCAGCGGGTGTTCTGCCGGGCGTAGGTGGTGCTGGCGTTCCGG 780
GTTTTAAGCCGCGCCCACGTCGCCCACAAGACGGCCCGCATCCACCACGACCGCAAGGCC
K F G A G A A G V L P G V G G A G V P G

781 GTGTTCCAGGTGCGATCCCGGGCATCGGTGGTATCGCAGGCGTAGGTACTCCGGCGGCCG 840
CACAAGGTCCACGCTAGGGCCCGTAGCCACCATAGCGTCCGCATCCATGAGGCCGCCGGC
V P G A I P G I G G I A G V G T P A A A

841 CTGCGGCTGCGGCAGCTGCGGCGAAAGCAGCTAAATACGGTGCGGCAGCAGGCCTGGTTC 900
GACGCCGACGCCGTCGACGCCGCTTTCGTCGATTTATGCCACGCCGTCGTCCGGACCAAG
A A A A A A A K A A K Y G A A A G L V P

Figure 1(2)

901 CGGGTGGTCCAGGCTTCGGTCCGGGTGTTGTAGGCGTTCCGGGTGCTGGTGTTCCGGGCG 960
GCCCACCAGGTCCGAAGCCAGGCCCACAACATCCGCAAGGCCCACGACCACAAGGCCCGC

G G P G F G P G V V G V P G A G V P G V

961 TAGGTGTTCCAGGTGCGGGCATCCCGGTTGTACCGGGTGCAGGTATCCCGGGCGCTGCGG 1020
ATCCACAAGGTCCACGCCCGTAGGGCCAACATGGCCCACGTCCATAGGGCCCGCGACGCC

G V P G A G I P V V P G A G I P G A A V

1021 TTCCAGGTGTTGTATCCCCGGAAGCGGCAGCTAAGGCTGCTGCGAAAGCTGCGAAATACG 1080
AAGGTCCACAACATAGGGGCCTTCGCCGTCGATTCCGACGACGCTTTCGACGCTTTATGC

P G V V S P E A A A K A A A K A A K Y G

1081 GAGCTCGTCCGGGCGTTGGTGTTGGTGGCATCCCGACCTACGGTGTAGGTGCAGGCGGTT 1140
CTCGAGCAGGCCCGCAACCACAACCACCGTAGGGCTGGATGCCACATCCACGTCCGCCAA

A R P G V G V G G I P T Y G V G A G G F

1141 TCCCAGGTTTCGGCGTTGGTGTTGGTGGCATCCCGGGTGTAGCTGGTGTTCCGTCTGTTG 1200
AGGGTCCAAAGCCGCAACCACAACCACCGTAGGGCCCACATCGACCACAAGGCAGACAAC

P G F G V G V G G I P G V A G V P S V G

1201 GTGGCGTACCGGGTGTTGGTGGCGTTCCAGGTGTAGGTATCTCCCCGGAAGCGCAGGCAG 1260
CACCGCATGGCCCACAACCACCGCAAGGTCCACATCCATAGAGGGGCCTTCGCGTCCGTC

G V P G V G G V P G V G I S P E A Q A A

1261 CTGCGGCAGCTAAAGCAGCGAAGTACGGCGTTGGTACTCCGGCGGCAGCAGCTGCTAAAG 1320
GACGCCGTCGATTTCGTCGCTTCATGCCGCAACCATGAGGCCGCCGTCGTCGACGATTTC

A A A K A A K Y G V G T P A A A A A K A

1321 CAGCGGCTAAAGCAGCGCAGTTCGGACTAGTTCCGGGCGTAGGTGTTGCGCCAGGTGTTG 1380
GTCGCCGATTTCGTCGCGTCAAGCCTGATCAAGGCCCGCATCCACAACGCGGTCCACAAC

A A K A A Q F G L V P G V G V A P G V G

Figure 1(3)

1381 GCGTAGCACCGGGTGTTGGTGTTGCTCCGGGCGTAGGTCTGGCACCGGGTGTTGGCGTTG 1440
CGCATCGTGGCCCACAACCACAACGAGGCCCGCATCCAGACCGTGGCCCACAACCGCAAC

V A P G V G V A P G V G L A P G V G V A

1441 CACCAGGTGTAGGTGTTGCGCCGGGCGTTGGTGTAGCACCGGGTATCGGTCCGGGTGGCG 1500
GTGGTCCACATCCACAACGCGGCCCGCAACCACATCGTGGCCCATAGCCAGGCCCACCGC

P G V G V A P G V G V A P G I G P G G V

1501 TTGCGGCTGCTGCGAAATCTGCTGCGAAGGTTGCTGCGAAAGCGCAGCTGCGTGCAGCAG 1560
AACGCCGACGACGCTTTAGACGACGCTTCCAACGACGCTTTCGCGTCGACGCACGTCGTC

A A A A K S A A K V A A K A Q L R A A A

1561 CTGGTCTGGGTGCGGGCATCCCAGGTCTGGGTGTAGGTGTTGGTGTTCCGGGCCTGGGTG 1620
GACCAGACCCACGCCCGTAGGGTCCAGACCCACATCCACAACCACAAGGCCCGGACCCAC

G L G A G I P G L G V G V G V P G L G V

1621 TAGGTGCAGGGGTACCGGGCCTGGGTGTTGGTGCAGGCGTTCCGGGTTTCGGTGCTGGCG 1680
ATCCACGTCCCCATGGCCCGGACCCACAACCACGTCCGCAAGGCCCAAAGCCACGACCGC

G A G V P G L G V G A G V P G F G A G A

1681 CGGACGAAGGTGTACGTCGTTCCCTGTCTCCAGAACTGCGTGAAGGTGACCCGTCCTCTT 1740
GCCTGCTTCCACATGCAGCAAGGGACAGAGGTCTTGACGCACTTCCACTGGGCAGGAGAA

D E G V R R S L S P E L R E G D P S S S

1741 CCCAGCACCTGCCGTCTACCCCGTCCTCTCCACGTGTTCCGGGCGCGCTGGCTGCTGCGA 1800
GGGTCGTGGACGGCAGATGGGGCAGGAGAGGTGCACAAGGCCCGCGCGACCGACGACGCT

Q H L P S T P S S P R V P G A L A A A K

1801 AAGCGGCGAAATACGGTGCAGCGGTTCCGGGTGTACTGGGCGGTCTGGGTGCTCTGGGCG 1860
TTCGCCGCTTTATGCCACGTCGCCAAGGCCCACATGACCCGCCAGACCCACGAGACCCGC

A A K Y G A A V P G V L G G L G A L G G

Figure 1(4)

1861 GTGTTGGTATCCCGGGCGGTGTTGTAGGTGCAGGCCCAGCTGCAGCTGCTGCTGCGGCAA 1920
CACAACCATAGGGCCCGCCACAACATCCACGTCCGGGTCGACGTCGACGACGACGCCGTT

V G I P G G V V G A G P A A A A A A A K

1921 AGGCAGCGGCGAAAGCAGCTCAGTTCGGTCTGGTTGGTGCAGCAGGTCTGGGCGGTCTGG 1980
TCCGTCGCCGCTTTCGTCGAGTCAAGCCAGACCAACCACGTCGTCCAGACCCGCCAGACC

A A A K A A Q F G L V G A A G L G G L G

1981 GTGTTGGCGGTCTGGGTGTACCGGGCGTTGGTGGTCTGGGTGGCATCCCGCCGGCGGCGG 2040
CACAACCGCCAGACCCACATGGCCCGCAACCACCAGACCCACCGTAGGGCGGCCGCCGCC

V G G L G V P G V G G L G G I P P A A A

2041 CAGCTAAAGCGGCTAAATACGGTGCAGCAGGTCTGGGTGGCGTTCTGGGTGGTGCTGGTC 2100
GTCGATTTCGCCGATTTATGCCACGTCGTCCAGACCCACCGCAAGACCCACCACGACCAG

A K A A K Y G A A G L G G V L G G A G Q

2101 AGTTCCCACTGGGCGGTGTAGCGGCACGTCCGGGTTTCGGTCTGTCCCCGATCTTCCCAG 2160
TCAAGGGTGACCCGCCACATCGCCGTGCAGGCCCAAAGCCAGACAGGGGCTAGAAGGGTC

F P L G G V A A R P G F G L S P I F P G

2161 GCGGTGCATGCCTGGGTAAAGCTTGCGGCCGTAAACGTAAATAATGATAG 2210
CGCCACGTACGGACCCATTTCGAACGCCGGCATTTGCATTTATTACTATCCTAG
G A C L G K A C G R K R K * * *

Figure 1(5)

```
  1 GGVPGAIPGGVPGGVFYPGAGLGALGGGALGPGGKPLKPVPGGLAGAGLG  50
    ||||||||||||||||||||||||||||||||||||||||||||||||||
  1 GGVPGAIPGGVPGGVFYPGAGLGALGGGALGPGGKPLKPVPGGLAGAGLG  50

 51 AGLGAFPAVTFPGALVPGGVADAAAAYKAAKAGAGLGGVPGVGGLGVSAG 100
    ||||||||||||||||||||||||||||||||||||||||||||||||||
 51 AGLGAFPAVTFPGALVPGGVADAAAAYKAAKAGAGLGGVPGVGGLGVSAG 100

101 AVVPQPGAGVKPGKVPGVGLPGVYPGGVLPGARFPGVGVLPGVPTGAGVK 150
    ||||||||||||||||||||||||||||||||||||||||||||||||||
101 AVVPQPGAGVKPGKVPGVGLPGVYPGGVLPGARFPGVGVLPGVPTGAGVK 150

151 PKAPGVGGAFAGIPGVGPFGGPQPGVPLGYPIKAPKLPGGYGLPYTTGKL 200
    ||||||||||||||||||||||||||||||||||||||||||||||||||
151 PKAPGVGGAFAGIPGVGPFGGPQPGVPLGYPIKAPKLPGGYGLPYTTGKL 200

201 PYGYGPGGVAGAAGKAGYPTGTGVGPQAAAAAAAKAAAKFGAGAAGVLPG 250
    ||||||||||||||||||||||||||||||||||||||||||||||||||
201 PYGYGPGGVAGAAGKAGYPTGTGVGPQAAAAAAAKAAAKFGAGAAGVLPG 250

251 VGGAGVPGVPGAIPGIGGIAGVGTPAAAAAAAAAAKAAKYGAAAGLVPGG 300
    ||||||||||||||||||||||||||||||||||||||||||||||||||
251 VGGAGVPGVPGAIPGIGGIAGVGTPAAAAAAAAAAKAAKYGAAAGLVPGG 300

301 PGFGPGVVGVPGAGVPGVGVPGAGIPVVPGAGIPGAAVPGVVSPEAAAKA 350
    ||||||||||||||||||||||||||||||||||||||||||||||||||
301 PGFGPGVVGVPGAGVPGVGVPGAGIPVVPGAGIPGAAVPGVVSPEAAAKA 350

351 AAKAAKYGARPGVGVGGIPTYGVGAGGFPGFGVGVGGIPGVAGVPSVGGV 400
    ||||||||||||||||||||||||||||||||||||||||||||||||||
351 AAKAAKYGARPGVGVGGIPTYGVGAGGFPGFGVGVGGIPGVAGVPSVGGV 400

401 PGVGGVPGVGISPEAQAAAAAKAAKYGVGTPAAAAAKAAAKAAQFGLVPG 450
    ||||||||||||||||||||||||||||||||||||||||||||||||||
401 PGVGGVPGVGISPEAQAAAAAKAAKYGVGTPAAAAAKAAAKAAQFGLVPG 450

451 VGVAPGVGVAPGVGVAPGVGLAPGVGVAPGVGVAPGVGVAPGIGPGGVAA 500
    ||||||||||||||||||||||||||||||||||||||||||||||||||
451 VGVAPGVGVAPGVGVAPGVGLAPGVGVAPGVGVAPGVGVAPGIGPGGVAA 500

501 AAKSAAKVAAKAQLRAAAGLGAGIPGLGVGVGVPGLGVGAGVPGLGVGAG 550
    ||||||||||||||||||||||||||||||||||||||||||||||||||
501 AAKSAAKVAAKAQLRAAAGLGAGIPGLGVGVGVPGLGVGAGVPGLGVGAG 550

551 VPGFGAGADEGVRRSLSPELREGDPSSSQHLPSTPSSPRVPGALAAAKAA 600
    ||||||                                 |||||||||||
551 VPGFGA.................................VPGALAAAKAA 567

601 KYGAAVPGVLGGLGALGGVGIPGGVVGAGPAAAAAAAKAAAKAAQFGLVG 650
    ||||||||||||||||||||||||||||||||||||||||||||||||||
568 KYGAAVPGVLGGLGALGGVGIPGGVVGAGPAAAAAAAKAAAKAAQFGLVG 617

651 AAGLGGLGVGGLGVPGVGGLGGIPPAAAAKAAKYGAAGLGGVLGGAGQFP 700
    ||||||||||||||||||||||||||||||||||||||||||||||||||
618 AAGLGGLGVGGLGVPGVGGLGGIPPAAAAKAAKYGAAGLGGVLGGAGQFP 667

701 LGGVAARPGFGLSPIFPGGACLGKACGRKRK 731
    |||||||||||||||||||||||||||||||
668 LGGVAARPGFGLSPIFPGGACLGKACGRKRK 698
```

Figure 2(1)

```
  1 ATGGGTGGCGTTCCGGGTGCTGTTCCGGGTGGCGTTCCGGGTGGTGTATT 50
    ||||||||||||||||||||||||||||||||||||||||||||||||||
  1 MetGlyGlyValProGlyAlaValProGlyGlyValProGlyGlyValPh 17

 51 CTACCCAGGCGCGGGTTTCGGTGCTGTTCCGGGTGGCGTTGCAGACGCAG 100
    ||||||||||||||||||||||||||||||||||||||||||||||||||
 18 eTyrProGlyAlaGlyPheGlyAlaValProGlyGlyValAlaAspAlaA 34

101 CTGCTGCGTACAAAGCGGCAAAGGCAGGTGCGGGTCTGGGCGGGGTACCA 150
    ||||||||||||||||||||||||||||||||||||||||||||||||||
 35 laAlaAlaTyrLysAlaAlaLysAlaGlyAlaGlyLeuGlyGlyValPro 50

151 GGTGTTGGCGGTCTGGGTGTATCTGCTGGCGCAGTTGTTCCGCAGCCGGG 200
    ||||||||||||||||||||||||||||||||||||||||||||||||||
 51 GlyValGlyGlyLeuGlyValSerAlaGlyAlaValValProGlnProGl 67

201 TGCAGGTGTAAAACCGGGCAAAGTTCCAGGTGTTGGTCTGCCGGGCGTAT 250
    ||||||||||||||||||||||||||||||||||||||||||||||||||
 68 yAlaGlyValLysProGlyLysValProGlyValGlyLeuProGlyValT 84

251 ACCCGGGTTTCGGTGCTGTTCCGGGCGCGCGTTTCCCAGGTGTTGGTGTA 300
    ||||||||||||||||||||||||||||||||||||||||||||||||||
 85 yrProGlyPheGlyAlaValProGlyAlaArgPheProGlyValGlyVal 100

301 CTGCCGGGCGTTCCGACCGGTGCAGGTGTTAAACCGAAGGCACCAGGTGT 350
    ||||||||||||||||||||||||||||||||||||||||||||||||||
101 LeuProGlyValProThrGlyAlaGlyValLysProLysAlaProGlyVa 117

351 AGGCGGCGCGTTCGCGGGTATCCCGGGTGTTGGCCCGTTCGGTGGTCCGC 400
    ||||||||||||||||||||||||||||||||||||||||||||||||||
118 lGlyGlyAlaPheAlaGlyIleProGlyValGlyProPheGlyGlyProG 134

401 AGCCAGGCGTTCCGCTGGGTTACCCGATCAAAGCGCCGAAGCTTCCAGGT 450
    ||||||||||||||||||||||||||||||||||||||||||||||||||
135 lnProGlyValProLeuGlyTyrProIleLysAlaProLysLeuProGly 150

451 GGCTACGGTCTGCCGTACACCACCGGTAAACTGCCGTACGGCTACGGTCC 500
    ||||||||||||||||||||||||||||||||||||||||||||||||||
151 GlyTyrGlyLeuProTyrThrThrGlyLysLeuProTyrGlyTyrGlyPr 167

501 GGGTGGCGTAGCAGGTGCTGCGGGTAAAGCAGGCTACCCAACCGGTACTG 550
    ||||||||||||||||||||||||||||||||||||||||||||||||||
168 oGlyGlyValAlaGlyAlaAlaGlyLysAlaGlyTyrProThrGlyThrG 184

551 GTGTTGGTCCGCAGGCTGCTGCGGCAGCTGCGGCGAAGGCAGCAGCAAAA 600
    ||||||||||||||||||||||||||||||||||||||||||||||||||
185 lyValGlyProGlnAlaAlaAlaAlaAlaAlaAlaLysAlaAlaAlaLys 200

601 TTCGGCGCGGGTGCAGCGGGTTTCGGTGCTGTTCCGGGCGTAGGTGGTGC 650
    ||||||||||||||||||||||||||||||||||||||||||||||||||
201 PheGlyAlaGlyAlaAlaGlyPheGlyAlaValProGlyValGlyGlyAl 217

651 TGGCGTTCCGGGTGTTCCAGGTGCGATCCCGGGCATCGGTGGTATCGCAG 700
    ||||||||||||||||||||||||||||||||||||||||||||||||||
218 aGlyValProGlyValProGlyAlaIleProGlyIleGlyGlyIleAlaG 234

701 GCGTAGGTACTCCGGCGGCCGCTGCGGCTGCGGCAGCTGCGGCGAAAGCA 750
    ||||||||||||||||||||||||||||||||||||||||||||||||||
235 lyValGlyThrProAlaAlaAlaAlaAlaAlaAlaAlaAlaAlaLysAla 250
```

Figure 3(1)

```
751  GCTAAATACGGTGCGGCAGCAGGCCTGGTTCCGGGTGGTCCAGGCTTCGG 800
     ||||||||||||||||||||||||||||||||||||||||||||||||||
251  AlaLysTyrGlyAlaAlaAlaGlyLeuValProGlyGlyProGlyPheGl 267

801  TCCGGGTGTTGTAGGCGTTCCGGGTTTCGGTGCTGTTCCGGGCGTAGGTG 850
     ||||||||||||||||||||||||||||||||||||||||||||||||||
268  yProGlyValValGlyValProGlyPheGlyAlaValProGlyValGlyV 284

851  TTCCAGGTGCGGGCATCCCGGTTGTACCGGGTGCAGGTATCCCGGGCGCT 900
     ||||||||||||||||||||||||||||||||||||||||||||||||||
285  alProGlyAlaGlyIleProValValProGlyAlaGlyIleProGlyAla 300

901  GCGGGTTTCGGTGCTGTATCCCCGGAAGCGGCAGCTAAGGCTGCTGCGAA 950
     ||||||||||||||||||||||||||||||||||||||||||||||||||
301  AlaGlyPheGlyAlaValSerProGluAlaAlaAlaLysAlaAlaAlaLy 317

951  AGCTGCGAAATACGGAGCTCGTCCGGGCGTTGGTGTTGGTGGCATCCCGA 1000
     ||||||||||||||||||||||||||||||||||||||||||||||||||
318  sAlaAlaLysTyrGlyAlaArgProGlyValGlyValGlyGlyIleProT 334

1001 CCTACGGTGTAGGTGCAGGCGGTTTCCCAGGTTTCGGCGTTGGTGTTGGT 1050
     ||||||||||||||||||||||||||||||||||||||||||||||||||
335  hrTyrGlyValGlyAlaGlyGlyPheProGlyPheGlyValGlyValGly 350

1051 GGCATCCCGGGTGTAGCTGGTGTTCCGTCTGTTGGTGGCGTACCGGGTGT 1100
     ||||||||||||||||||||||||||||||||||||||||||||||||||
351  GlyIleProGlyValAlaGlyValProSerValGlyGlyValProGlyVa 367

1101 TGGTGGCGTTCCAGGTGTAGGTATCTCCCCGGAAGCGCAGGCAGCTGCGG 1150
     ||||||||||||||||||||||||||||||||||||||||||||||||||
368  lGlyGlyValProGlyValGlyIleSerProGluAlaGlnAlaAlaAlaA 384

1151 CAGCTAAAGCAGCGAAGTACGGCGTTGGTACTCCGGCGGCAGCAGCTGCT 1200
     ||||||||||||||||||||||||||||||||||||||||||||||||||
385  laAlaLysAlaAlaLysTyrGlyValGlyThrProAlaAlaAlaAlaAla 400

1201 AAAGCAGCGGCTAAAGCAGCGCAGTTCGGACTAGTTCCGGGCGTAGGTGT 1250
     ||||||||||||||||||||||||||||||||||||||||||||||||||
401  LysAlaAlaAlaLysAlaAlaGlnPheGlyLeuValProGlyValGlyVa 417

1251 TGCGCCAGGTGTTGGCGTAGCACCGGGTGTTGGTGTTGCTCCGGGCGTAG 1300
     ||||||||||||||||||||||||||||||||||||||||||||||||||
418  lAlaProGlyValGlyValAlaProGlyValGlyValAlaProGlyValG 434

1301 GTCTGGCACCGGGTGTTGGCGTTGCACCAGGTGTAGGTGTTGCGCCGGGC 1350
     ||||||||||||||||||||||||||||||||||||||||||||||||||
435  lyLeuAlaProGlyValGlyValAlaProGlyValGlyValAlaProGly 450

1351 GTTGGTGTAGCACCGGGTATCGGTCCGGGTGGCGTTGCGGCTGCTGCGAA 1400
     ||||||||||||||||||||||||||||||||||||||||||||||||||
451  ValGlyValAlaProGlyIleGlyProGlyGlyValAlaAlaAlaAlaLy 467

1401 ATCTGCTGCGAAGGTTGCTGCGAAAGCGCAGCTGCGTGCAGCAGCTGGTC 1450
     ||||||||||||||||||||||||||||||||||||||||||||||||||
468  sSerAlaAlaLysValAlaAlaLysAlaGlnLeuArgAlaAlaAlaGlyL 484

1451 TGGGTGCGGGCATCCCAGGTCTGGGTGTAGGTGTTGGTGTTCCGGGCCTG 1500
     ||||||||||||||||||||||||||||||||||||||||||||||||||
485  euGlyAlaGlyIleProGlyLeuGlyValGlyValGlyValProGlyLeu 500
```

Figure 3(2)

```
1501 GGTGTAGGTGCAGGGGTACCGGGCCTGGGTGTTGGTGCAGGCGTTCCGGG 1550
     ||||||||||||||||||||||||||||||||||||||||||||||||||
 501 GlyValGlyAlaGlyValProGlyLeuGlyValGlyAlaGlyValProGl 517

1551 TTTCGGTGCTGTTCCGGGCGCGCTGGCTGCTGCGAAAGCGGCGAAATACG 1600
     ||||||||||||||||||||||||||||||||||||||||||||||||||
 518 yPheGlyAlaValProGlyAlaLeuAlaAlaAlaLysAlaAlaLysTyrG 534

1601 GTGCTGTTCCGGGTGTACTGGGCGGTCTGGGTGCTCTGGGCGGTGTTGGT 1650
     ||||||||||||||||||||||||||||||||||||||||||||||||||
 535 lyAlaValProGlyValLeuGlyGlyLeuGlyAlaLeuGlyGlyValGly 550

1651 ATCCCGGGCGGTGTTGTAGGTGCAGGCCCAGCTGCAGCTGCTGCTGCGGC 1700
     ||||||||||||||||||||||||||||||||||||||||||||||||||
 551 IleProGlyGlyValValGlyAlaGlyProAlaAlaAlaAlaAlaAlaAl 567

1701 AAAGGCAGCGGCGAAAGCAGCTCAGTTCGGTCTGGTTGGTGCAGCAGGTC 1750
     ||||||||||||||||||||||||||||||||||||||||||||||||||
 568 aLysAlaAlaAlaLysAlaAlaGlnPheGlyLeuValGlyAlaAlaGlyL 584

1751 TGGGCGGTCTGGGTGTTGGCGGTCTGGGTGTACCGGGCGTTGGTGGTCTG 1800
     ||||||||||||||||||||||||||||||||||||||||||||||||||
 585 euGlyGlyLeuGlyValGlyGlyLeuGlyValProGlyValGlyGlyLeu 600

1801 GGTGGCATCCCGCCGGCGGCGGCAGCTAAAGCGGCTAAATACGGTGCAGC 1850
     ||||||||||||||||||||||||||||||||||||||||||||||||||
 601 GlyGlyIleProProAlaAlaAlaAlaLysAlaAlaLysTyrGlyAlaAl 617

1851 AGGTCTGGGTGGCGTTCTGGGTGGTGCTGGTCAGTTCCCACTGGGCGGTG 1900
     ||||||||||||||||||||||||||||||||||||||||||||||||||
 618 aGlyLeuGlyGlyValLeuGlyGlyAlaGlyGlnPheProLeuGlyGlyV 634

1901 TAGCGGCACGTCCGGGTTTCGGTCTGTCCCCGATCTTCCCAGGCGGTGCA 1950
     ||||||||||||||||||||||||||||||||||||||||||||||||||
 635 alAlaAlaArgProGlyPheGlyLeuSerProIlePheProGlyGlyAla 650

1951 TGCCTGGGTAAAGCTTGCGGCCGTAAACGTAAA 1983
     |||||||||||||||||||||||||||||||||
 651 CysLeuGlyLysAlaCysGlyArgLysArgLys 661
```

Figure 3(3)

```
  1 ATGGGTGGCGTTCCGGGTGCTGTTCCGGGTGGCGTTCCGGGTGGTGTATT 50
    ||||||||||||||||||||| | ||||||||||||||||||||||||||
  1 ATGGGTGGCGTTCCGGGTGCTATCCCGGGTGGCGTTCCGGGTGGTGTATT 50

 51 CTACCCAGGCGCGGGTTTCGGTGC.......................... 74
    |||||||||||||||| | |||||
 51 CTACCCAGGCGCGGGTCTGGGTGCACTGGGCGGTGGTGCGCTGGGCCCGG 100
                              .
                              .
                              .
 75 ...............................................TGT 77
                                                    ||
151 GGTGCAGGTCTGGGCGCGTTCCCGGCGGTTACCTTCCCGGGTGCTCTGGT 200

 78 TCCGGGTGGCGTTGCAGACGCAGCTGCTGCGTACAAAGCGGCAAAGGCAG 127
    ||||||||||||||||||||||||||||||||||||||||||||||||||
201 TCCGGGTGGCGTTGCAGACGCAGCTGCTGCGTACAAAGCGGCAAAGGCAG 250

128 GTGCGGGTCTGGGCGGGGTACCAGGTGTTGGCGGTCTGGGTGTATCTGCT 177
    ||||||||||||||||||||||||||||||||||||||||||||||||||
251 GTGCGGGTCTGGGCGGGGTACCAGGTGTTGGCGGTCTGGGTGTATCTGCT 300

178 GGCGCAGTTGTTCCGCAGCCGGGTGCAGGTGTAAAACCGGGCAAAGTTCC 227
    ||||||||||||||||||||||||||||||||||||||||||||||||||
301 GGCGCAGTTGTTCCGCAGCCGGGTGCAGGTGTAAAACCGGGCAAAGTTCC 350

228 AGGTGTTGGTCTGCCGGGCGTATACCCGGGTTTCGGTGCTGTTCCGGGCG 277
    |||||||||||||||||||||||||||||||   |||| | | |||||||
351 AGGTGTTGGTCTGCCGGGCGTATACCCGGGT...GGTGTTCTGCCGGGCG 397

278 CGCGTTTCCCAGGTGTTGGTGTACTGCCGGGCGTTCCGACCGGTGCAGGT 327
    ||||||||||||||||||||||||||||||||||||||||||||||||||
398 CGCGTTTCCCAGGTGTTGGTGTACTGCCGGGCGTTCCGACCGGTGCAGGT 447

328 GTTAAACCGAAGGCACCAGGTGTAGGCGGCGCGTTCGCGGGTATCCCGGG 377
    ||||||||||||||||||||||||||||||||||||||||||||||||||
448 GTTAAACCGAAGGCACCAGGTGTAGGCGGCGCGTTCGCGGGTATCCCGGG 497

378 TGTTGGCCCGTTCGGTGGTCCGCAGCCAGGCGTTCCGCTGGGTTACCCGA 427
    ||||||||||||||||||||||||||||||||||||||||||||||||||
498 TGTTGGCCCGTTCGGTGGTCCGCAGCCAGGCGTTCCGCTGGGTTACCCGA 547

428 TCAAAGCGCCGAAGCTTCCAGGTGGCTACGGTCTGCCGTACACCACCGGT 477
    ||||||||||||||||||||||||||||||||||||||||||||||||||
548 TCAAAGCGCCGAAGCTTCCAGGTGGCTACGGTCTGCCGTACACCACCGGT 597

478 AAACTGCCGTACGGCTACGGTCCGGGTGGCGTAGCAGGTGCTGCGGGTAA 527
    ||||||||||||||||||||||||||||||||||||||||||||||||||
598 AAACTGCCGTACGGCTACGGTCCGGGTGGCGTAGCAGGTGCTGCGGGTAA 647

528 AGCAGGCTACCCAACCGGTACTGGTGTTGGTCCGCAGGCTGCTGCGGCAG 577
    ||||||||||||||||||||||||||||||||||||||||||||||||||
648 AGCAGGCTACCCAACCGGTACTGGTGTTGGTCCGCAGGCTGCTGCGGCAG 697

578 CTGCGGCGAAGGCAGCAGCAAAATTCGGCGCGGGTGCAGCGGGTTTCGGT 627
    |||||||||||||||||||||||||||||||||||||||||      |||
698 CTGCGGCGAAGGCAGCAGCAAAATTCGGCGCGGGTGCAGCG......GGT 741

628 GCTGTTCCGGGCGTAGGTGGTGCTGGCGTTCCGGGTGTTCCAGGTGCGAT 677
    | | | ||||||||||||||||||||||||||||||||||||||||||||
742 GTTCTGCCGGGCGTAGGTGGTGCTGGCGTTCCGGGTGTTCCAGGTGCGAT 791
```

Figure 4(1)

```
              .         .         .         .         .
 678 CCCGGGCATCGGTGGTATCGCAGGCGTAGGTACTCCGGCGGCCGCTGCGG 727
     ||||||||||||||||||||||||||||||||||||||||||||||||||
 792 CCCGGGCATCGGTGGTATCGCAGGCGTAGGTACTCCGGCGGCCGCTGCGG 841
              .         .         .         .         .
 728 CTGCGGCAGCTGCGGCGAAAGCAGCTAAATACGGTGCGGCAGCAGGCCTG 777
     ||||||||||||||||||||||||||||||||||||||||||||||||||
 842 CTGCGGCAGCTGCGGCGAAAGCAGCTAAATACGGTGCGGCAGCAGGCCTG 891
              .         .         .         .         .
 778 GTTCCGGGTGGTCCAGGCTTCGGTCCGGGTGTTGTAGGCGTTCCGGGTTT 827
     ||||||||||||||||||||||||||||||||||||||||||||||||
 892 GTTCCGGGTGGTCCAGGCTTCGGTCCGGGTGTTGTAGGCGTTCCGGGT.. 939
              .         .         .         .         .
 828 CGGTGCTGTTCCGGGCGTAGGTGTTCCAGGTGCGGGCATCCCGGTTGTAC 877
      | || ||||||||||||||||||||||||||||||||||||||||||||
 940 .GCTGGTGTTCCGGGCGTAGGTGTTCCAGGTGCGGGCATCCCGGTTGTAC 988
              .         .         .         .         .
 878 CGGGTGCAGGTATCCCGGGCGCTGCGGGTTTCGGTGCTGTATCCCCGGAA 927
     ||||||||||||||||||||||||||| |   |||| |||||||||||||
 989 CGGGTGCAGGTATCCCGGGCGCTGCGGTTCCAGGTGTTGTATCCCCGGAA 1038
              .         .         .         .         .
 928 GCGGCAGCTAAGGCTGCTGCGAAAGCTGCGAAATACGGAGCTCGTCCGGG 977
     ||||||||||||||||||||||||||||||||||||||||||||||||||
1039 GCGGCAGCTAAGGCTGCTGCGAAAGCTGCGAAATACGGAGCTCGTCCGGG 1088
              .         .         .         .         .
 978 CGTTGGTGTTGGTGGCATCCCGACCTACGGTGTAGGTGCAGGCGGTTTCC 1027
     ||||||||||||||||||||||||||||||||||||||||||||||||||
1089 CGTTGGTGTTGGTGGCATCCCGACCTACGGTGTAGGTGCAGGCGGTTTCC 1138
              .         .         .         .         .
1028 CAGGTTTCGGCGTTGGTGTTGGTGGCATCCCGGGTGTAGCTGGTGTTCCG 1077
     ||||||||||||||||||||||||||||||||||||||||||||||||||
1139 CAGGTTTCGGCGTTGGTGTTGGTGGCATCCCGGGTGTAGCTGGTGTTCCG 1188
              .         .         .         .         .
1078 TCTGTTGGTGGCGTACCGGGTGTTGGTGGCGTTCCAGGTGTAGGTATCTC 1127
     ||||||||||||||||||||||||||||||||||||||||||||||||||
1189 TCTGTTGGTGGCGTACCGGGTGTTGGTGGCGTTCCAGGTGTAGGTATCTC 1238
              .         .         .         .         .
1128 CCCGGAAGCGCAGGCAGCTGCGGCAGCTAAAGCAGCGAAGTACGGCGTTG 1177
     ||||||||||||||||||||||||||||||||||||||||||||||||||
1239 CCCGGAAGCGCAGGCAGCTGCGGCAGCTAAAGCAGCGAAGTACGGCGTTG 1288
              .         .         .         .         .
1178 GTACTCCGGCGGCAGCAGCTGCTAAAGCAGCGGCTAAAGCAGCGCAGTTC 1227
     ||||||||||||||||||||||||||||||||||||||||||||||||||
1289 GTACTCCGGCGGCAGCAGCTGCTAAAGCAGCGGCTAAAGCAGCGCAGTTC 1338
              .         .         .         .         .
1228 GGACTAGTTCCGGGCGTAGGTGTTGCGCCAGGTGTTGGCGTAGCACCGGG 1277
     ||||||||||||||||||||||||||||||||||||||||||||||||||
1339 GGACTAGTTCCGGGCGTAGGTGTTGCGCCAGGTGTTGGCGTAGCACCGGG 1388
              .         .         .         .         .
1278 TGTTGGTGTTGCTCCGGGCGTAGGTCTGGCACCGGGTGTTGGCGTTGCAC 1327
     ||||||||||||||||||||||||||||||||||||||||||||||||||
1389 TGTTGGTGTTGCTCCGGGCGTAGGTCTGGCACCGGGTGTTGGCGTTGCAC 1438
              .         .         .         .         .
1328 CAGGTGTAGGTGTTGCGCCGGGCGTTGGTGTAGCACCGGGTATCGGTCCG 1377
     ||||||||||||||||||||||||||||||||||||||||||||||||||
1439 CAGGTGTAGGTGTTGCGCCGGGCGTTGGTGTAGCACCGGGTATCGGTCCG 1488
              .         .         .         .         .
1378 GGTGGCGTTGCGGCTGCTGCGAAATCTGCTGCGAAGGTTGCTGCGAAAGC 1427
     ||||||||||||||||||||||||||||||||||||||||||||||||||
1489 GGTGGCGTTGCGGCTGCTGCGAAATCTGCTGCGAAGGTTGCTGCGAAAGC 1538
```

Figure 4(2)

```
1428 GCAGCTGCGTGCAGCAGCTGGTCTGGGTGCGGGCATCCCAGGTCTGGGTG 1477
     ||||||||||||||||||||||||||||||||||||||||||||||||||
1539 GCAGCTGCGTGCAGCAGCTGGTCTGGGTGCGGGCATCCCAGGTCTGGGTG 1588

1478 TAGGTGTTGGTGTTCCGGGCCTGGGTGTAGGTGCAGGGGTACCGGGCCTG 1527
     ||||||||||||||||||||||||||||||||||||||||||||||||||
1589 TAGGTGTTGGTGTTCCGGGCCTGGGTGTAGGTGCAGGGGTACCGGGCCTG 1638

1528 GGTGTTGGTGCAGGCGTTCCGGGTTTCGGTGC.................. 1559
     ||||||||||||||||||||||||||||||||
1639 GGTGTTGGTGCAGGCGTTCCGGGTTTCGGTGCTGGCGCGGACGAAGGTGT 1688

                              .
                              .
                              .

1560 ...............................TGTTCCGGGCGCGCTGGCT 1578
                                    |||||||||||||||||||
1739 AGCACCTGCCGTCTACCCCGTCCTCTCCACGTGTTCCGGGCGCGCTGGCT 1788

1579 GCTGCGAAAGCGGCGAAATACGGT...GCTGTTCCGGGTGTACTGGGCGG 1625
     ||||||||||||||||||||||||   || ||||||||||||||||||||
1789 GCTGCGAAAGCGGCGAAATACGGTGCAGCGGTTCCGGGTGTACTGGGCGG 1838

1626 TCTGGGTGCTCTGGGCGGTGTTGGTATCCCGGGCGGTGTTGTAGGTGCAG 1675
     ||||||||||||||||||||||||||||||||||||||||||||||||||
1839 TCTGGGTGCTCTGGGCGGTGTTGGTATCCCGGGCGGTGTTGTAGGTGCAG 1888

1676 GCCCAGCTGCAGCTGCTGCTGCGGCAAAGGCAGCGGCGAAAGCAGCTCAG 1725
     ||||||||||||||||||||||||||||||||||||||||||||||||||
1889 GCCCAGCTGCAGCTGCTGCTGCGGCAAAGGCAGCGGCGAAAGCAGCTCAG 1938

1726 TTCGGTCTGGTTGGTGCAGCAGGTCTGGGCGGTCTGGGTGTTGGCGGTCT 1775
     ||||||||||||||||||||||||||||||||||||||||||||||||||
1939 TTCGGTCTGGTTGGTGCAGCAGGTCTGGGCGGTCTGGGTGTTGGCGGTCT 1988

1776 GGGTGTACCGGGCGTTGGTGGTCTGGGTGGCATCCCGCCGGCGGCGGCAG 1825
     ||||||||||||||||||||||||||||||||||||||||||||||||||
1989 GGGTGTACCGGGCGTTGGTGGTCTGGGTGGCATCCCGCCGGCGGCGGCAG 2038

1826 CTAAAGCGGCTAAATACGGTGCAGCAGGTCTGGGTGGCGTTCTGGGTGGT 1875
     ||||||||||||||||||||||||||||||||||||||||||||||||||
2039 CTAAAGCGGCTAAATACGGTGCAGCAGGTCTGGGTGGCGTTCTGGGTGGT 2088

1876 GCTGGTCAGTTCCCACTGGGCGGTGTAGCGGCACGTCCGGGTTTCGGTCT 1925
     ||||||||||||||||||||||||||||||||||||||||||||||||||
2089 GCTGGTCAGTTCCCACTGGGCGGTGTAGCGGCACGTCCGGGTTTCGGTCT 2138

1926 GTCCCCGATCTTCCCAGGCGGTGCATGCCTGGGTAAAGCTTGCGGCCGTA 1975
     ||||||||||||||||||||||||||||||||||||||||||||||||||
2139 GTCCCCGATCTTCCCAGGCGGTGCATGCCTGGGTAAAGCTTGCGGCCGTA 2188

1976 AACGTAAATAATGATAG 1992
     |||||||||||||||||
2189 AACGTAAATAATGATAG 2205
```

Figure 4(3)

```
        10        20        30        40        50        60        70        80
MGGVPGAIPGGVPGGVFYPGAGLGALGGGALGPGGKPLKPVPGGLAGAGLGAGLGAFPAVTFPGALVPGGVADAAAAYKA
::::::: :::::::::                    :        ::  :      : :: ::::::::::::::
MGGVPGAVPGGVPGGVFY---------------------P--------GA--G------F-GA-VPGGVADAAAAYKA
        10                                        20                  30

        90       100       110       120       130       140       150
AKAGAGLGGVPGVGGLGVSAGAVVPQPGAGVKPGKVPGVGLPGVYPG-GVLPGARFPGVGVLPGVPTGAGVKPKAPGVGG
::::::::::::::::::::::::::::::::::::::::::::::: :  :::::::::::::::::::::::::::::
AKAGAGLGGVPGVGGLGVSAGAVVPQPGAGVKPGKVPGVGLPGVYPGFGAVPGARFPGVGVLPGVPTGAGVKPKAPGVGG
         50        60        70        80        90       100       110

       170       180       190       200       210       220       230
AFAGIPGVGPFGGPQPGVPLGYPIKAPKLPGGYGLPYTTGKLPYGYGPGGVAGAAGKAGYPTGTGVGPQAAAAAAAKAAA
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
AFAGIPGVGPFGGPQPGVPLGYPIKAPKLPGGYGLPYTTGKLPYGYGPGGVAGAAGKAGYPTGTGVGPQAAAAAAAKAAA
       130       140       150       160       170       180       190

          250       260       270       280       290       300       310
KFGAGAA--GVLPGVGGAGVPGVPGAIPGIGGIAGVGTPAAAAAAAAAKAAKYGAAAGLVPGGPGFGPGVVGVPGAG-V
:::::::  :  ::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::: : :
KFGAGAAGFGAVPGVGGAGVPGVPGAIPGIGGIAGVGTPAAAAAAAAAKAAKYGAAAGLVPGGPGFGPGVVGVPGFGAV
       210       220       230       240       250       260       270

 320       330       340       350       360       370       380       390
PGVGVPGAGIPVVPGAGIPGAAVPGVVSPEAAAKAAAKAAKYGARPGVGVGGIPTYGVGAGGFPGFGVGVGGIPGVAGVP
:::::::::::::::::::::  : :::::::::::::::::::::::::::::::::::::::::::::::::::::::
PGVGVPGAGIPVVPGAGIPGAAGFGAVSPEAAAKAAAKAAKYGARPGVGVGGIPTYGVGAGGFPGFGVGVGGIPGVAGVP
       290       300       310       320       330       340       350
```

Figure 5(1)

```
400       410       420       430       440       450       460       470
SVGGVPGVGGVPGVGISPEAQAAAAAKAAKYGVGTPAAAAAKAAAKAAQFGLVPGVGVAPGVGVAPGVGVAPGVGLAPGV
:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
SVGGVPGVGGVPGVGISPEAQAAAAAKAAKYGVGTPAAAAAKAAAKAAQFGLVPGVGVAPGVGVAPGVGVAPGVGLAPGV
        370       380       390       400       410       420       430

480       490       500       510       520       530       540       550
GVAPGVGVAPGVGVAPGIGPGGVAAAAKSAAKVAAKAQLRAAAGLGAGIPGLGVGVGVPGLGVGAGVPGLGVGAGVPGFG
::::::::::::::::  :::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
GVAPGVGVAPGVGVAPGIGPGGVAAAAKSAAKVAAKAQLRAAAGLGAGIPGLGVGVGVPGLGVGAGVPGLGVGAGVPGF-
        450       460       470       480       490       500       510

560       570       580       590       600       610       620       630
AGADEGVRRSLSPELREGDPSSSQHLPSTPSSPRVPGALAAAKAAKYGAAVPGVLGGLGALGGVGIPGGVVGAGPAAAAA
::                                :::::::::::::: :::::::::::::::::::::::::::::::
GA--------------------------------VPGALAAAKAAKYG-AVPGVLGGLGALGGVGIPGGVVGAGPAAAAA
                                          530       540       550       560

640       650       660       670       680       690       700       710
AAKAAAKAAQFGLVGAAGLGGLGVGGLGVPGVGGLGGIPPAAAAKAAKYGAAGLGGVLGGAGQFPLGGVAARPGFGLSPI
::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
AAKAAAKAAQFGLVGAAGLGGLGVGGLGVPGVGGLGGIPPAAAAKAAKYGAAGLGGVLGGAGQFPLGGVAARPGFGLSPI
 570       580       590       600       610       620       630       640

720       730
FPGGACLGKACGRKRK
::::::::::::::::
FPGGACLGKACGRKRK
650       660
```

Figure 5(2)

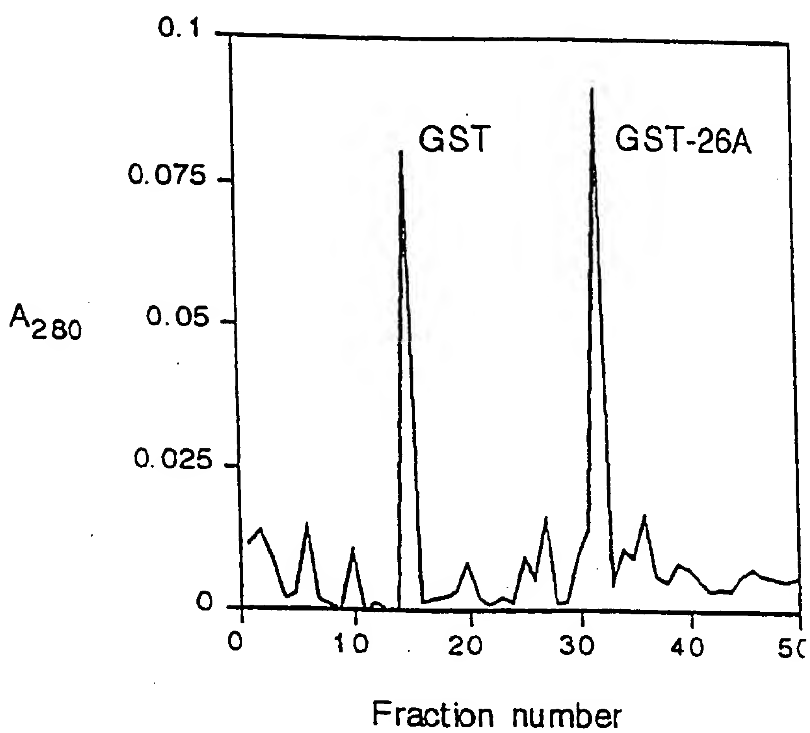
0.1
0.075
0.05
0.025
0
A280
GST
GST-26A
0
10
20
30
40
50
Fraction number

Fig. 6(a)

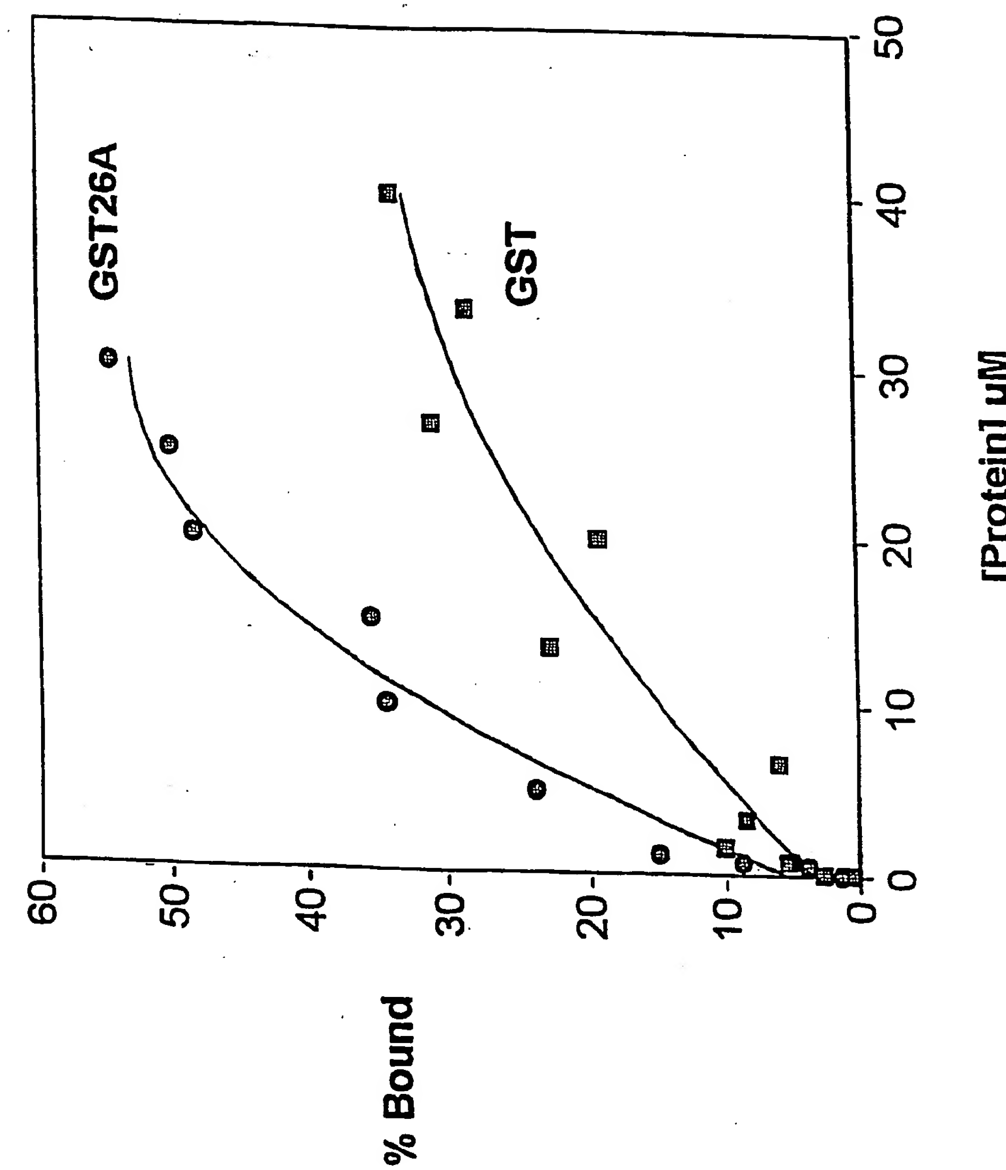


Fig. 6(b)

```
948 TCCGCCATGGGAGGTGTTCCGGGCGCGCTGGCTGCTGCGAAAGCGGCGAA 997
    ||||||||||||||||||||||||||||||||||||||||||||||||||
  1 SerAlaMetGlyGlyValProGlyAlaLeuAlaAlaAlaLysAlaAlaLy 17

 998 ATACGGTGCAGCGGTTCCGGGTGTACTGGGCGGTCTGGGTGCTCTGGGCG 1047
     ||||||||||||||||||||||||||||||||||||||||||||||||||
  18 sTyrGlyAlaAlaValProGlyValLeuGlyGlyLeuGlyAlaLeuGlyG 34

1048 GTGTTGGTATCCCGGGCGGTGTTGTAGGTGCAGGCCCAGCTGCAGCTGCT 1097
     ||||||||||||||||||||||||||||||||||||||||||||||||||
  35 lyValGlyIleProGlyGlyValValGlyAlaGlyProAlaAlaAlaAla 50

1098 GCTGCGGCAAAGGCAGCGGCGAAAGCAGCTCAGTTCGGTCTGGTTGGTGC 1147
     ||||||||||||||||||||||||||||||||||||||||||||||||||
  51 AlaAlaAlaLysAlaAlaAlaLysAlaAlaGlnPheGlyLeuValGlyAl 67

1148 AGCAGGTCTGGGCGGTCTGGGTGTTGGCGGTCTGGGTGTACCGGGCGTTG 1197
     ||||||||||||||||||||||||||||||||||||||||||||||||||
  68 aAlaGlyLeuGlyGlyLeuGlyValGlyGlyLeuGlyValProGlyValG 84

1198 GTGGTCTGGGTGGCATCCCGCCGGCGGCGGCAGCTAAAGCGGCTAAATAC 1247
     ||||||||||||||||||||||||||||||||||||||||||||||||||
  85 lyGlyLeuGlyGlyIleProProAlaAlaAlaAlaLysAlaAlaLysTyr 100

1248 GGTGCAGCAGGTCTGGGTGGCGTTCTGGGTGGTGCTGGTCAGTTCCCACT 1297
     ||||||||||||||||||||||||||||||||||||||||||||||||||
 101 GlyAlaAlaGlyLeuGlyGlyValLeuGlyGlyAlaGlyGlnPheProLe 117

1298 GGGCGGTGTAGCGGCACGTCCGGGTTTCGGTCTGTCCCCGATCTTCCCAG 1347
     ||||||||||||||||||||||||||||||||||||||||||||||||||
 118 uGlyGlyValAlaAlaArgProGlyPheGlyLeuSerProIlePheProG 134

1348 GCGGTGCATGCCTGGGTAAAGCTTGCGGCCGTAAACGTAAA 1388
     |||||||||||||||||||||||||||||||||||||||||
 135 lyGlyAlaCysLeuGlyLysAlaCysGlyArgLysArgLys 147
```

Figure 7

```
 948 TCCGCCATGGGAGCTCTGGTAGGCCTGGGCGTACCGGGCCTGGGTGTTGG 997
     ||||||||||||||||||||||||||||||||||||||||||||||||||
   1 SerAlaMetGlyAlaLeuValGlyLeuGlyValProGlyLeuGlyValGl 17

 998 TGCAGGCGTTCCGGGTTTCGGTGCTGGCGCGGACGAAGGTGTACGTCGTT 1047
     ||||||||||||||||||||||||||||||||||||||||||||||||||
  18 yAlaGlyValProGlyPheGlyAlaGlyAlaAspGluGlyValArgArgS 34

1048 CCCTGTCTCCAGAACTGCGTGAAGGTGACCCGTCCTCTTCCCAGCACCTG 1097
     ||||||||||||||||||||||||||||||||||||||||||||||||||
  35 erLeuSerProGluLeuArgGluGlyAspProSerSerSerGlnHisLeu 50

1098 CCGTCTACCCCGTCCTCTCCACGTGTTCCGGGCGCGCTGGCTGCTGCGAA 1147
     ||||||||||||||||||||||||||||||||||||||||||||||||||
  51 ProSerThrProSerSerProArgValProGlyAlaLeuAlaAlaAlaLy 67

1148 AGCGGCGAAATACGGTGCAGCGGTTCCGGGTGTACTGGGCGGTCTGGGTG 1197
     ||||||||||||||||||||||||||||||||||||||||||||||||||
  68 sAlaAlaLysTyrGlyAlaAlaValProGlyValLeuGlyGlyLeuGlyA 84

1198 CTCTGGGCGGTGTTGGTATCCCGGGCGGTGTTGTAGGTGCAGGCCCAGCT 1247
     ||||||||||||||||||||||||||||||||||||||||||||||||||
  85 laLeuGlyGlyValGlyIleProGlyGlyValValGlyAlaGlyProAla 100
```

Figure 8(1)

```
1248 GCAGCTGCTGCTGCGGCAAAGGCAGCGGCGAAAGCAGCTCAGTTCGGTCT 1297
     ||||||||||||||||||||||||||||||||||||||||||||||||||
 101 AlaAlaAlaAlaAlaAlaLysAlaAlaAlaLysAlaAlaGlnPheGlyLe 117
          .         .         .         .         .
1298 GGTTGGTGCAGCAGGTCTGGGCGGTCTGGGTGTTGGCGGTCTGGGTGTAC 1347
     ||||||||||||||||||||||||||||||||||||||||||||||||||
 118 uValGlyAlaAlaGlyLeuGlyGlyLeuGlyValGlyGlyLeuGlyValP 134
          .         .         .         .         .
1348 CGGGCGTTGGTGGTCTGGGTGGCATCCCGCCGGCGGCGGCAGCTAAAGCG 1397
     ||||||||||||||||||||||||||||||||||||||||||||||||||
 135 roGlyValGlyGlyLeuGlyGlyIleProProAlaAlaAlaAlaLysAla 150
          .         .         .         .         .
1398 GCTAAATACGGTGCAGCAGGTCTGGGTGGCGTTCTGGGTGGTGCTGGTCA 1447
     ||||||||||||||||||||||||||||||||||||||||||||||||||
 151 AlaLysTyrGlyAlaAlaGlyLeuGlyGlyValLeuGlyGlyAlaGlyGl 167
          .         .         .         .         .
1448 GTTCCCACTGGGCGGTGTAGCGGCACGTCCGGGTTTCGGTCTGTCCCCGA 1497
     ||||||||||||||||||||||||||||||||||||||||||||||||||
 168 nPheProLeuGlyGlyValAlaAlaArgProGlyPheGlyLeuSerProI 184
          .         .         .         .         .
1498 TCTTCCCAGGCGGTGCATGCCTGGGTAAAGCTTGCGGCCGTAAACGTAAA 1547
     ||||||||||||||||||||||||||||||||||||||||||||||||||
 185 lePheProGlyGlyAlaCysLeuGlyLysAlaCysGlyArgLysArgLys 200
```

Figure 8(2)